THURSDAY, NOVEMBER 30, 1899.

THE INHERITANCE OF DEAFNESS.

Marriages of the Deaf in America. By Edward Allen Fay. Pp. 527. (Washington: The Volta Bureau, 1898.)

MR. FAY'S work is an inquiry concerning the results of marriages of the deaf in America, a research originally instituted by Dr. A. Graham Bell among the charges which he committed to the Volta Bureau when he endowed that institution. When Mr. Fay undertook this work—as a labour of love—the resources of the Bureau were placed at his disposal, and he was further helped in his investigations by his Government appointment as a special agent for the collection of statistics relating to the deaf of the United States during the taking of the eleventh census. By these means Mr. Fay was particularly well equipped for his work, and the volume before us is no mean result. Taking as the chief aims of his inquiry the solution of certain questions of interest and importance to the deaf as a class and as individuals, he has sought by all the means in his power to obtain satisfactory replies, and his success will be seen by all who care to give the book a careful study. The questions to be elucidated were as follows:—

(1) Are marriages of deaf persons more liable to result in deaf offspring than ordinary marriages?

(2) Are marriages in which both of the partners are deaf more liable to result in deaf offspring than marriages in which one of the partners is deaf and the other is a hearing person?

(3) Are certain classes of the deaf, however they may marry, more liable than others to have deaf children? If so, how are these classes respectively composed, and what are the conditions that increase or diminish this liability?

(4) Aside from the question of the liability of the offspring to deafness, are marriages in which both of the partners are deaf more likely to result happily than marriages in which one of the partners is deaf and the other a hearing person?

These are questions which have been submitted to considerable discussion both in Europe and America, with the result that the conclusions arrived at have differed widely. Indeed the conclusions have ranged between the dictum of Graham Bell, that "the evidence shows a tendency to the formation of a deaf variety of the human race in America," on the one hand, to that of the Commissioners of the Irish census of 1881, that "it appears evident that the question of deafness and dumbness in parents has no influence in propagating the defect."

Mr. Fay's inquiry commenced in 1889, and the work has continued uninterruptedly since that time. Exhaustive questions were sent out and about, and the replies received were both more numerous and more complete than was anticipated.

It would be beyond the purpose or scope of this review to enter with any detail into the large number of statistics placed before Mr. Fay's readers; suffice it to say that they bear the stamp of having been most carefully collected, tested, and arranged, and may therefore be taken as more trustworthy than statistics are usually found to be. In the tabular statement of marriages details are given of no less than 4471 unions—a fact that will give the reader some idea of the onerous nature of Mr. Fay's task.

It appears that marriages of the deaf are more common in America than in Europe, and they have increased at a high rate of progression during the present century. From the statistics it appears that marriages of deaf persons, one or both of the partners being deaf, are far more liable to result in deaf offspring than ordinary marriages. The proportion of deaf marriages resulting in deaf offspring is 9·7 per cent., and the proportion of deaf children born therefrom is 8·6 per cent. Accurate data as to the proportion of deaf children born of ordinary marriages are not easily obtainable, but that proportion is probably less than 1·10 per cent. On the other hand, marriages of the deaf are far more likely to result in hearing offspring, the proportion of hearing children being 75 per cent.

These results are in accordance with the two laws of heredity: (1) that a physical anomaly tends to be transmitted to the offspring, and (2) that offspring tend to revert to the normal type.

There is a greater liability to deaf offspring of marriages of the congenitally deaf, since congenital or innate characteristics are far more likely to be transmitted than are acquired characteristics.

It appears also that deaf persons having deaf relatives, however they are married, and hearing persons having deaf relatives and married to deaf partners, are very liable to have deaf offspring. Finally, the marriages of the deaf most liable to result in deaf children are those in which the partners are related by consanguinity.

The most important statistics (summed up in a separate table) are those showing the number of marriages of each class of which the results are reported and the number and percentage of each class resulting in deaf children, with the number of children born from marriages of each class, and giving the number and percentage of those deaf. These statistics show the comparative liability to deaf offspring of the several classes of marriages.

As regards the *happiness* of deaf unions, marriages in which both parties are deaf appear to be more likely, other things being equal, to result happily than those in which one of the partners is deaf and the other possesses normal hearing; the proportion of divorces and separations in the former class being 2·5 per cent., in the latter 6·4 per cent. This is easily explainable on the grounds of mutual fellowship and identity of social relations and sympathies which arise from the union of individuals suffering from similar conditions.

An appendix is devoted to illegitimate unions, but the totals of their statistics are too small to furnish any certain basis for trustworthy conclusions.

Mr. Fay has produced a valuable work, and one which should take a prominent place in the literature—necessarily not a very large one—of the subject. From a careful perusal one cannot fail to note the clearness of his statements and the logical way in which he works out his deductions. There is but one thing lacking, and that is the devotion of any special chapter to those diseases of the ear—notably the condition known as middle ear sclerosis—acknowledged to be hereditary, or to the diseases of the throat and nose which are predisposing causes of deficient hearing power. Considering the large percentage of all forms of nasal obstruction existing in the condition of civilisation—a percentage larger, we believe, in America than in Europe—it would be of interest to investigate the influences diseases of the throat and nose exercise upon the marriages of persons suffering therefrom.

In spite of the fact that statistics are always somewhat dry, and the deductions given from those in Mr. Fay's work are put without useless verbiage, the book is a very readable one to those interested in all branches of the subject, and should rank high as a work of reference.

MACLEOD YEARSLEY.

THE LIQUEFACTION OF GASES.

The Rise and Development of the Liquefaction of Gases. By Willett L. Hardin, Ph.D. Pp. viii+250. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1899.)

La Liquéfaction des Gaz et ses Applications. By Prof. Julien Lefèvre. Pp. 175. (Paris: Gauthier-Villars et Fils, and Masson et Cie.)

A BOOK should be criticised with reference to the author's professed object in writing it. Dr. Hardin professes to have written for the popular reader, in the popular science style. Regarded from this point of view the work deserves a good deal of praise. It is, in the first place, interesting to read, collecting, as it does, a great many facts connected with the development of low-temperature research, and detailing numerous experiments which are explained with the assistance of copious and clear illustrations. It may therefore be recommended, with the reservations which are made below, to those who, with a very elementary knowledge of physics, desire to learn something of the details of recent progress in a very interesting subject. The recommendation should be all the heartier because the author's style is free from the patriotic brag and boom which disfigure another recent American book on the same subject, and because the right side is taken as to the marvellous industrial revolutions heralded from America as a consequence of later work in this department of science. A further merit in the work is the abundance of exact references to original authorities, for the benefit, as stated in the preface, of those who wish for fuller information.

The fact, however, that the author had the latter object in view emphasises what should be a binding obligation even in books intended solely for popular reading, namely, to take care that such science as is introduced shall be strictly correct; and this obligation Dr. Hardin has fallen short of in a serious degree. On pp. 183–185 he reproduces Edwin J. Houston's suggestions for an apparatus to produce intense refrigeration. The nearest thing to a novelty in these suggestions is the proposal to modify Windhausen's machine by substituting a two-stage compressor for a single-stage one, and so obtaining a higher pressure of sixty atmospheres. He expressly retains Windhausen's system of power expansion in a cylinder doing work on a piston; yet Dr. Hardin says:

"In the apparatus suggested, Houston anticipated the methods which were employed twenty years later in the liquefaction of air by Linde, Hampson and Tripler."

This is inexcusable in one who undertakes to "enable the popular reader to understand the principles involved." The same confusion is repeated much more deliberately later on. On pp. 205–208 the author works out mathematically the formula for the cooling produced by power expansion, $\left(\frac{p}{p_1}\right)^{\frac{k-1}{k}} = \frac{T}{T_1}$, which he calls equation (7). He then says:

"Applying these results to the liquefaction of gases by means of the regenerative coil, it is evident that the expansion of the gas in the tube lowers the temperature by an amount which corresponds to equation (7)."

The formula for power expansion is here applied where we ought to have had Thomson's formula for free expansion, $-\frac{d\theta}{dp} = A\left(\frac{273\cdot7}{t}\right)^2$. The title of the section is "Theory of the Self-intensification Method of Refrigeration," and a note, at the foot of the same page, refers us to Joule and Thomson for a more complete discussion, which, however, in the body of the section, instead of being abridged or summarised, is altogether replaced by another analysis. The way in which the book is written gives no reason to suppose that Dr. Hardin is incapable of distinguishing between the very different conditions involved in power-expansion and free expansion, or the very different mathematical analyses appropriate to these two sets of conditions. The only tolerable explanation of such a gross confusion is that it has never come in Dr. Hardin's way to read Thomson's papers on the cooling of gases by free expansion, or to examine intimately the nature of the phenomena involved, and so he has carelessly applied to these phenomena the well-known formula for cooling by power-expansion. This is not the proper way to write a book even for the satisfaction of the interest of the popular reader. These are not the only instances that the author shows of a lack of thorough acquaintance with his subject. If he had studied Mr. Tripler's British patent of 1893, which is put forth as the foundation of his claims as inventor of a form of self-intensive air-liquefier, and had paid attention to the chronology of the subject, Dr. Hardin would perhaps not have felt justified in treating those claims so well as he has done, by describing those parts of Mr. Tripler's apparatus which are not kept secret. On p. 227, the author gives Prof. Dewar's conclusion, that the liquefying points of hydrogen and helium are near together, without giving the subsequent correction.

The style of the writing is occasionally careless and slipshod, and the meaning sometimes undiscoverable. On p. 209 we are told

"the issuing jet experiences a much greater decrease in temperature owing to the greater difference between the initial and final pressures."

This is unintelligible in view of the fact that the difference between the initial and final pressures does not increase, while in case of supply from a cylinder of compressed gas, it actually decreases. On p. 232 we find the sentence: "Below the temperature of zero degrees ice slowly sublimes." Some misprints have escaped correction. On p. 208 the minus sign is omitted between k and 1 in equation (7). On p. 243 the second "i" in the name Lavoisier has been omitted.

If in a new edition such mistakes be corrected, and the latter part of Chapter iv., Section 3, be rewritten, the book will be useful as well as interesting to the class of readers for whom it is chiefly intended.

Prof. Lefèvre's book is very well written and clearly illustrated. Within the narrow limits of 175 pages it contains a considerable amount of correct theory, a very interesting history of the experimental development of gas-liquefaction, some discussion of industrial applications, and a very full list of references to original authorities; and all this with a surprising freedom from the evils of over-compression. The arrangement is not altogether perfect. Prof. Dewar's apparatus figured on pp. 55 and 61 apply the combination of free expansion with counter-current interchange, a method of which there was earlier authenticated invention both in England and Germany. These applications should have been described in Section 35 under the head "Machines à détente sans travail extérieur," and after the invention on which they depend; or, if it was thought advisable to discuss them out of chronological order, their dependence on the combination in that invention should have been clearly brought out. The illustration of Mr. Tripler's apparatus on p. 84 might well have been omitted. The employment of three-stage compressors, with cooling coils between the stages, with purifiers, water-separators, and pressure-gauge, was familiar to pneumatic engineers for years before they were employed by Mr. Tripler in liquefying air; and the vitally important interchanger and expansion valve remain such a mystery that the illustration gives no idea what they are like or whether they differ essentially from the invention of Dr. Linde and Dr. Hampson. On p. 70 the statement that helium was liquefied at the temperature of boiling hydrogen needs correcting in accordance with later results. Chapter ix., on modern commercial refrigerating machines, is very much out of proportion with the rest of the book; a discussion of this subject, which entirely passes by the great American and British developments in this field, might as well be omitted altogether.

A CONTRIBUTION TO ZOO-GEOGRAPHY.

Studien zur Geographie. Von Dr. W. Kobelt. Zweiter Band. Pp. x + 369. (Wiesbaden: Kreidel, 1898.)

IN this, the second part of his "studies," Dr. Kobelt deals at full length with the characteristics of the fauna and to some extent also, of the flora of the "Meridional Sub-region." This region very nearly corresponds to the Mediterranean sub-region of Dr. Wallace; its northern limits are a trifle more extensive, embracing as they do the Crimea and Bessarabia.

As might be expected from the nature of his own zoological studies, the author lays most stress upon the distribution of Mollusca, and gives a series of elaborate and apparently very full tables of species found in the different departments into which he divides the region described in this volume. It must not, however, be inferred from this that other groups of animals are neglected or even treated with indifference.

A great deal is said about the range of the vertebrata of this part of the world in the past as well as in the present, all the orders of that assemblage of animals being taken into consideration. There is one group of terrestrial, aquatic and semi-aquatic invertebrates which are not at all discussed by Dr. Kobelt. This group—that of the earthworms and their allies—might profitably have been dealt with, inasmuch as their range, so far as is known, marks out very well not only the limits of the Palæarctic region (excluding only Japan), but also enables a line to be drawn between the more northern and the Mediterranean portions of the region dealt with by Dr. Kobelt. Inasmuch as a large portion of the meridional region is occupied by the Mediterranean sea, the author is, we think, wise in paying some attention to the fauna of that sea, as well as of other stretches of water included within his area. A special chapter is devoted to the Mediterranean, and the author commences by addressing himself to the problem as to whether that inland sea is really an independent tract or a section of the Atlantic.

The colossal faunistic and structural monographs issued by the Naples Zoological Station, as well as the results of elaborate studies carried on at similar institutions along the coasts of the Mediterranean, have made us well acquainted with the shallow water fauna of that sea. We are less informed as to the pelagic creatures, especially mammals, and about the deep-sea fauna. As to the former, observes the author, "the mammalogist will, with a regretful shrug of the shoulders, confess himself incompetent" to speak with accuracy. So far as we know, the whales are not special to that sea; nor does palæontological evidence hint at the Mediterranean as a centre of origin. Oliver Goldsmith, in his "Animated Nature," pointed out that the Mediterranean dolphin occurred in the Red Sea. He was doubtless right, though the reasoning employed may have been defective, and there is no prevision of the Suez Canal! The sperm whale is found therein, and (if we may regard the sea beast from which Perseus delivered Andromeda as a "monstrous physetere"!) was even known to the ancients. Pliny's Orca was, it appears, rather that "sea should'ring whale" than a gladiator. The dolphin of the Mediterranean has received many names, but there seems to be little doubt that that whale of Greek coins is exactly the same as the dolphin of the coasts of the Atlantic. "As concerns mammals," concludes Dr. Kobelt, "the Mediterranean is an impoverished gulf of the Atlantic Ocean."

In the characteristics of the Mollusca found, and some other animals, the Mediterranean presents tropical characters which are, partly at least, in reality due to the Suez Canal. Mr. E. A. Smith, of the Natural History Museum, contributed some years since a number of interesting facts to the Zoological Society bearing upon such immigrations. The Mediterranean, as is well known, sinks in places to profoundly abyssal depths; the actually greatest depth appears to be 4400 metres; but here no living organisms have been found. It is purely azoic; the reason for the want of life is, according to the author, the want of oxygen and the abundance of carbonic acid.

There is, in fact, no special deep-sea fauna found in this large tract of water.

Turning to the terrestrial mammalia, the author comes to the conclusion (elaborated in a special and highly interesting chapter) that their range to-day is in thorough agreement with the distribution of land and water. The Mediterranean southwards and the Bosphorus westwards form barriers which divide faunas. This is illustrative of what is apt to be a common error in text-books of zoology. When Mr. Sclater originally divided up the earth into zoological regions, he did not profess to do so for more than the Passerine birds, though his conclusions were shown later by himself and by others to apply to other groups also. They do not, however, in the least apply to various invertebrate groups; and in dogmatically dividing the world into the Sclaterian regions, the writers of some text-books have entirely lost the prime object of such a regional division. The more modern Eutherian mammals are controlled in their range by what are largely existing barriers; the more ancient molluscs show in their distribution the non-existence of such barriers in ancient times. Dr. Kobelt dwells upon the distinctness of northern Africa from Europe so far as concerns its mammalian inhabitants. He is disposed to dismiss the Gibraltar monkey as truly indigenous to that peninsula, though admitting the occurrence of fossil allies in European strata of Pleistocene and Pliocene age.

On the whole, however, we are not certain that Dr. Kobelt has taken so fortunate an instance as he might have done to illustrate the effects of modern barriers in the dispersal of mammals. It is perhaps a little too strong, in the face of the lists which he gives, to state of the Straits of Gibraltar and the narrow passage opposite to Carthage that they are "faunistic boundaries of the first rank." The division between the arctic and the non-arctic parts of the palæarctic region are more easily defined from their mammalian indigenes.

Dr. Kobelt's book is closely packed with solid fact, and there is no more speculation than is necessary to give prominence to such generalisations as appear to him to be the legitimate outcome of his laboriously collected material. This has been amassed from the most diverse sources; and the author by no means disdains the older writers, even the ancients being laid under contribution. We commend the book to the serious student of zoogeography only, for it is emphatically not to be trifled with in an arm-chair. F. E. B.

A TEXT-BOOK OF HEAT MOTORS.

The Steam Engine and Gas and Oil Engines. By John Perry, D.Sc., F.R.S. Pp. viii + 646. (London: Macmillan and Co., Ltd., 1899.)

THIS is one of the best books which has been published in this country on the steam engine and other heat motors. The method and style is thoroughly characteristic of Prof Perry. Many will no doubt object to the order of arrangement of the various chapters, and will be inclined to think the author has put the cart before the horse; the author will probably reply that the book was not written for the beginner, but for advanced students.

There is something to be said for the plan adopted; if a text-book for students, engaged during the day in practical engine work, is given up in its early chapters almost entirely to the properties of steam and thermodynamic problems, there is great risk that the student will be discouraged and eventually give up the attempt to improve his knowledge of the principles underlying the working of heat motors.

The author's plan is to deal first with the more practical details, in the hope probably that in mastering these the student will find out what he lacks and what he needs of thermodynamics and kindred subjects. Granted this, it is still a little difficult to see that an improvement would not be effected by putting Chapters xv., xviii. and xix. on methods of calculation, on temperature and heat, and on the properties of steam, earlier in the book. This is shown by the necessity of a footnote on p. 99 to explain the way in which the total heat required in evaporating a pound of steam is determined.

Chapter ii. is devoted to description of cylinders, pistons, valves, frames, &c., of what the author calls the commonest form of steam engine, but as the details explained include parts of steam turbines, the title is hardly happy. The illustrations in this chapter are extremely good and complete.

Chapter iii. deals with the value of expansion, and the author points out, as a result of his calculations, that there are limits of economic expansion, and how easily the Willan's law can be deduced from such calculations.

Chapter iv. describes the indicator, its construction and the proper way to use it, and the errors it is liable to. Then, in the following chapter, come a most valuable series of exercises on calculations from indicator cards.

One of the chief merits of the book, apart from the fact that it is so thoroughly up to date in all its information and methods, is the way in which almost every chapter is filled with numerical exercises; any student genuinely working these out for himself cannot fail to become thoroughly master of the main problems confronting the student of heat motors.

In this chapter again (v.) we have a little awkwardness introduced from the particular arrangement adopted by the author. One of the exercises is the drawing of a $\theta\phi$ diagram, and no explanation of this has been given, the reader is referred for explanations to a much later chapter of the book. We fear the student is not likely to start with much knowledge of entropy, and will therefore probably skip these sections.

The next eight chapters are devoted to the mechanical details of valves, governors, air pumps, boilers and their fittings and accessories.

The first fourteen chapters may be said to mainly deal with the mechanical details of engines and boilers; while the rest of the book is devoted to what may be called theory and principle.

In Chapter xvi. the author deals with the cost of production of energy and the efficiency of various types of motors, a most complete and valuable chapter full of good examples. Then come some chapters on temperature and heat, properties of steam, and work, &c., all very thorough and very full of matter for careful thought.

In the chapter on the $\theta\phi$ diagrams, more advanced theory is taken up; and, in fact, there are several chapters here that will be above the average student, and will form good reading for the expert; the facts are marshalled with great skill, and the deductions show that the author is a thorough master of his subject.

The chapters on valve motion problems and inertia of moving parts are good, and the methods adopted to deal with these very difficult problems are as simple as it is possible for them to be.

Though only forty-two pages are devoted to gas and oil engines, the author has managed to get in a great amount of most useful information, and to give all that the general student needs.

The remaining chapters are devoted to certain important thermodynamic problems and to an inquiry into the properties of superheated steam.

Most certainly Prof. Perry has produced a text-book which must be on the shelf of every student of applied thermodynamics, and of every engineer who has to deal with the utilisation of energy. H. B.

OUR BOOK SHELF.

Practical Plane and Solid Geometry for Advanced Students; including Graphic Statics. By J. Harrison, M.I.M.E., and G. A. Baxandall. Pp. xii + 558. (Macmillan and Co., 1889.)

THIS book appears to compare very favourably with most English works of its class. The greater part of it deals with practical solid geometry, including the method of indexed plans; this subject is treated in a much more methodical way than is usually the case, and the authors very properly call attention from time to time to constructions which are of a fundamental character. It is a pity they did not go further, and clearly distinguish throughout the book the worked examples which involve new points of theory from those which merely illustrate general constructions previously given. The directions for making cardboard models ought to be very useful to the student; and the constructions are explained in such a way as to make the reasons for them intelligible. The section on plane geometry is distinctly above the average; in particular, there is a very interesting discussion of the description of an ellipse by means of a paper trammel. Of graphical statics only a brief outline is given; but it is useful enough so far as it goes. There is one error to which attention ought to be drawn: on p. 342 it is stated that the tangent plane to a surface at an anticlastic point cuts the surface in a curve with a double point *where there are two inflexions*: this is not generally the case, and, in fact, the anchor-ring gives an example of the contrary. Here the section is a bicircular quartic which has a real ordinary node when the tangent plane cuts the ring, and is not parallel to the polar axis.

Grundlinien der maritimen Meteorologie. By W. Köppen. Pp. vi + 83. (Hamburg: G. W. Hiemeyer, 1899.)

THIS little work serves two purposes; it is practically a concise elementary meteorology, and a guide for the use of sailors, showing the best routes in the different oceans, with directions for the management of vessels in storms, especially the dangerous West India hurricanes and the typhoons of the China seas. Dr. Köppen has been known for many years as one of the most prominent meteorologists, and having access to the large amount of materials collected by the Deutsche Seewarte, we might expect to find the result of his long experience embodied in a useful and an attractive form. The work meets our expectations in every way; all details which are unnecessary for the object in view have been carefully excluded, while all technical and nautical expressions are fully explained, so that the work, which is specially written for seamen, may be read with interest and advantage by all who are desirous of obtaining a knowledge of maritime meteorology. His treatment of the subject includes the general circulation of the atmosphere, as well as the movements of waves, tides and ocean currents, and the value of the treatise is much enhanced by explanatory figures in the text and by separate charts and diagrams.

Inorganic Chemical Preparations. By Felix Lengfeld. Pp. xviii + 57. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1899.)

THIS is a compact series of instructions for the preparation of typical inorganic compounds, the selection of which seems to have been very judiciously made. References to original literature are given in connection with each preparation. The author takes care to explain "that the manual is merely a laboratory guide, and that unless the work is carefully supervised, it may become purely mechanical, and the course lose half its value." It is, in fact, a series of recipes, and no attempt is made to explain the innumerable difficulties that will confront the inexperienced worker. This is not said by way of complaint; on the contrary, it is the incidental and unexpected difficulties of an operation rather than the plain sailing that give the operator occasion to think, and lead to the close association of the teacher with the mind of the learner.

Mr. Lengfeld purposely refrains from giving a complete list of references to literature, being of opinion that the student should learn to use dictionaries of chemistry. It is doubtful, however, whether the student is able to make a discreet choice from the innumerable references of a dictionary, and we think that the author has rather lost an opportunity in not making his list of references more ample. To those teachers who are introducing more inorganic preparation work into their courses, this book is likely to prove welcome. A. S.

The Utility of Sulphate of Ammonia in Agriculture. By James Muir, M.R.A.C. Pp. 68. (London: Sulphate of Ammonia Committee, 4 Fenchurch Avenue, E.C., 1899.)

THIS is the essay which won the prize lately offered by the Sulphate of Ammonia Committee. Mr. Muir has carefully compiled his little treatise, and made a judicious selection of results of field experiments to illustrate the use of sulphate of ammonia, and to compare its results with those obtained from the use of nitrate of soda. Naturally, the results of the Rothamsted experiments are those most largely drawn upon; Woburn is also quoted from to a considerable extent, and the author considerately always gives references to his authorities. The comparisons between the effects of nitrate of soda and sulphate of ammonia are fully and very fairly drawn, and the farmer should find the essay a great help in deciding which of these nitrogenous manures to apply in any particular case. No doubt the farmer, for whom the essay is chiefly written, will turn to the last three pages, which contain a summary of conclusions and comparisons between the two important nitrogenous manures. This summary is in twenty-seven paragraphs, and but few of these lay themselves open to criticism. We can only suggest that the author might have pointed out more clearly in this summary, paragraph 3, that leguminous plants can, under favourable conditions, make use of free nitrogen; paragraph 7, that nitrogenous manures, and *especially* ammoniacal manures, do not give their best results unless plenty of ash constituents are present, phosphates as well as potash; paragraph 20, that phosphates are a highly desirable addition in the manuring of barley; and paragraphs 24 and 27, that both phosphates and potash should be used on potatoes and on grass-land when sulphate of ammonia is used to supply nitrogen.

The Committee is to be congratulated on having secured and published a very useful and very justly written essay.

Euclid. Books I.-IV. Edited by Charles Smith and Sophie Bryant. Pp. viii + 288. (London: Macmillan and Co., 1899.)

WITH this book we have another addition to the great number of text-books on the Elements of Geometry. Its chief features seem to be that the editors endeavour to instil into the students the notion that it is the correct reasoning and proof of the propositions which should be mastered, and not so much an exact repetition of the words of the text-book or teacher.

Abbreviations are freely used early in the first book, and these should be adopted generally by beginners, as the reasoning of a proof can be more easily scanned. The editors have in several cases departed from Euclid's solutions and adopted in their stead more modern and simple methods. Included in the text are many examples, both original and selected, from mathematical journals and examination papers. In this form the Elements should be found useful in many schools.

Sylvia in Flowerland. By Linda Gardiner. Pp. 198. (London: Seeley and Co., Ltd., 1899.)

AN attempt is here made to employ the methods of Lewis Carroll in the teaching of botany. In the first chapter the foxglove explains: "This is Leap Year with us (the flowers), and so we have a thirty-first of June," and because the thirty-first of June does not occur every year, it is a day of special favour to humans, who are allowed "to hear with both eyes and ears." Sylvia talks with plant after plant, and is instructed by them in the fascinating mysteries of cross-pollenation and many other interesting questions of plant-life. The jam is sometimes scarcely thick enough to hide the powder; but we have little doubt that the volume will find many appreciative readers.

Magnetism and Electricity. By J. Paley Yorke. Pp. viii + 264. (London: Edward Arnold, 1899.)

MR. YORKE'S object is to provide an introduction to this branch of physics for those students who already possess some acquaintance with general elementary science. His treatment is non-mathematical, and no precise instructions are given for experimental work. It is a little difficult to understand the reason for the interpolation of chapter v., headed "Electricity," between the subjects of magnetism and the study of electric currents, more especially as the subject of electrostatics is resumed in chapter xii. The explanations are clear and simple, and the book should give an intelligent reader sound preliminary conceptions of an important subject.

Field and Folklore. By Harry Lowerison. With a chapter on Folklore by Alfred Nutt. Pp. vii + 77. (London: David Nutt, 1899.)

THE collection of short essays on various aspects of nature-study collected here should do a great deal towards enlisting the sympathy of school teachers in developing a love in their pupils for outdoor observations of animal and plant-life. Mr. Lowerison gives, in an informal way, a series of useful hints as to how to set about observing nature, and what books to consult to find the explanation of observations which are not at first easily understood. Mr. Nutt's chapter describes the scope of folklore and the aims of students of this department of knowledge.

LETTERS TO THE EDITOR.

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

The Stockholm Conference on the Exploration of the Sea.

I CANNOT refrain from addressing to you a few words in support of Prof. Herdman's remarks on the outcome of the Stockholm Conference. With marine biology so eminently represented at the meetings, there was ground for an expectation that the report would contain primarily recommendations for work at sea. The representatives of chemical and physical work appear to have known their minds and to have obtained the just recognition of their claims.

Hitherto in biological investigation work has been too exclusively devoted to the food fishes themselves—too little to the food of these fishes—far too little to their biological environment. It will be to many eager students, both of fishery affairs and marine biology, a matter of dismay if nothing more definite results from this Conference. There are, and have been, too many committees, secretaries and bureaus engaged on this subject. As Prof. Herdman says, we want work at sea. To be precise, we want, to begin with, two well-equipped trawlers and the right men in them. If the Stockholm Conference had recommended even one, it would have been a sign of grace. Such boats are not mere scientific instruments—not merely the luxuries afforded by governments in times of prosperity—but sound financial investments in fishery affairs. The Norwegian Government has, I understand, ordered one, admirably devised for marine investigation. GEORGE MURRAY.

November 25.

Bust of Sir George Stokes.

YOU were kind enough to say last June that Mr. Hamo Thornycroft would undertake the production of bronze copies of the presentation bust of Sir George Stokes, about one-third of the size of the original, at a cost of seven guineas each, in case twenty-five were ordered, and that names would be received by Sir William Crookes and myself.

If anybody wants such a copy I hope that he will write to me at once. JOHN PERRY.

Royal College of Science, London, South Kensington, S.W., November 22.

A Geometric Determination of the Median Value of a System of Normal Variants, from two of its Centiles.

A SHORT account appeared in NATURE, October 12, p. 584, of a paper read by me at the British Association, entitled the "Median Estimate," which will appear in the forthcoming Journal of the Association. Its object was to solve a problem of the following kind:—40 per cent. of the members at a meeting vote that a proposed grant should be less than 100*l.*, 80 per cent. vote that it should exceed 500*l.* What is the Median Estimate, supposing the normal law of frequency to hold good? That is to say, What is the sum that one-half of the members would think too little, and the other half too much, and which therefore presents the best compromise between many discordant opinions? I showed that the calculation was exceedingly simple if certain tabular values are used that will be spoken of later. But, on after reflection, it seems to me that further simplification is both desirable and feasible. The problem is representative of a large class of much importance to anthropologists in the field, few of whom appear to be quick at arithmetic or acquainted even with the elements of algebra. They often desire to ascertain the physical characteristics of races who are too timorous or suspicious to be measured individually, but who could easily be dealt with by my method. Suppose it to be a question of strength, as measured by lifting power, and that it has been ascertained that *a per cent.* of them fail to lift a certain bag A of known weight, and that *b per cent.* of them fail to lift another heavier bag B. From these two data, the median strength can be determined by the simple method spoken of above, and not only it but also the distribution of strengths among the people. Having indicated the utility and importance of the general problem, I will proceed to work out the particular case of the voters by the now further simplified method. In Fig. 2 let the base line G represent 100*l*. and let each successive horizontal line above it represent an increment of 100*l*. A dot A is placed on G, at the division 40°, and another dot B is placed on the ordinate at the division 80° at the level of the fourth line above G. Therefore A and B are plotted at their respective places. Join the two dots with a straight line. The place where this line cuts the ordinate at 50°, shows the Median value. The principle on which this exceedingly simple process rests must be explained by beginning with Fig. 1, where an ordinary curve of distribution is drawn about the axis H, with a quartile equal to 1. The

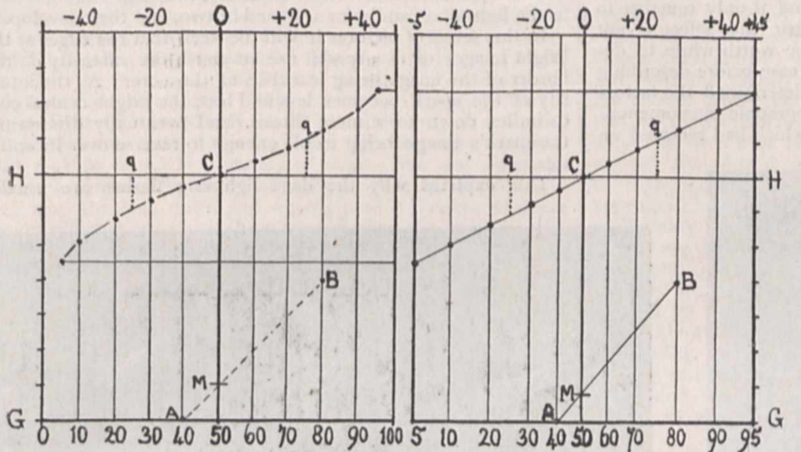


Fig 1. {Limits, 0° to 100°, otherwise, 0° to ±50°.   Fig 2 {Limits 5° to 95° otherwise 0° to ±45°

centiles from the axis to the curve are given in the following small table (see my "Natural Inheritance," Macmillan, 1889) which is reproduced here for convenience.

Centiles to the grades 0° *to* ± 50° (*negative for negative grades, positive for positive grades*).

±	0	1°	2°	3°	4°	5°	6°	7°	8°	9°
0°	0·00	0·04	0·07	0·11	0·15	0·19	0·22	0·26	0·30	0·34
10°	0·38	0·41	0·45	0·49	0·53	0·57	0·61	0·65	0·69	0·74
20°	0·78	0 82	0·86	0·91	0·95	1·00	1·05	1·10	1·15	1·20
30°	1·25	1·30	1·36	1·42	1·47	1·54	1·60	1·67	1·74	1·82
40°	1·90	1·99	2·08	2·19	2·31	2·44	2·65	2·79	3·05	3·45

The theoretical values for ± 50° are infinitely large.
The curve ceases to be trustworthy outside about ± 45°.

When A and B are plotted on Fig. 1 there can be only one normal curve of frequency whose steepness, as measured by its quartile, allows it to pass through both of them. This curve might be drawn, but by a tedious process of trial and error, to avoid which the arrangement shown in Fig. 2 has been devised, and the troublesome curve is dispensed with. The ordinates in Fig. 1 are so stretched apart or compressed together, laterally, that the curve is changed into a straight line. Let x be any abscissa in Fig. 1, counting from the middle of the axis to the right or left as the case may be, and let y be the corresponding tabular value. Then, as in Fig. 2, draw an abscissa x' of the same *nominal* length as x, but of a real length $= ny$, where $n = 1$ or some more convenient number. Now let p_1, p_2, p_3, &c., be points on the curve in Fig. 1, having the co-ordinates x_1, y_1; x_2, y_2; x_3, y_3, &c., then the corresponding points in Fig. 2 will occupy positions having the co-ordinates of ny_1, y_1; ny_2, y_2; ny_3, y_3, &c. In other words, they will lie in the same straight line. The ordinates of any normal curve are expressed by multiplying the tabular numbers by the quartile of that curve. Let q be the quartile of any given curve, and write n' for nq. Then substituting n' for n in the above, we still find that p_1, p_2, p_3, &c., will lie in the same straight line in Fig. 2. Consequently the proposition is true generally.

Prof. Karl Pearson informs me that various curves representing technological formulæ were similarly translated into straight lines by Lalanne, and discussed by him in a series of papers (1846–1878). He termed the process by which a proper choice of scales enables us to represent a given curve by a straight line, *anamorphic geometry*. Prof. Pearson also tells me that in Lalanne's hands and in those of his followers (Hermann, Vogler, Kapteyn, &c.) this geometry has been of great service in exhibiting engineering and other data in a form suitable for easy reckoning.

A convenient scale for the pocket book may be made on a strip of paper squarely ruled in millimetres, on which the tabular numbers divided by 4 and multiplied by 100 are entered. Its range between ± 45° is consequently $100 \times \frac{1}{4} \times (2 \times 2{\cdot}44) =$ 122 millimetres, which is less than 5 inches, or than the length of a half sheet of ordinary notepaper. The scale is to be used for plotting the values of a, b, and m, while the millimetre graduations along the opposite edge of the strip serve for the ordinates A and B. For frequent service, a ruled blank form, like Fig. 2, is quicker in use, and it need not, I think, be larger than half a sheet of foolscap paper, or eight inches wide. This would suffice to show clearly each alternate centile, as about the middle of the form, where the centiles lie closest together, the alternate centiles would be more than one-tenth of an inch apart.

An attempt is made at the bottom of Fig. 1 to exhibit the amount of error that would be produced by a simple interpolation between A and B, but it is better to make the comparison numerically.

Let a and b be the percentage of those who vote, &c., for less than A and B respectively, and let α and β be the tabular numbers *including their signs*, corresponding to a and b, on the scale reckoned from 0° to 100° (and not from 0° to ± 50°). Let m be the unknown median and q the unknown quartile of that curve of normal frequency which passes through the plotted positions of A and B, then

$$m + q\alpha = \mathrm{A} \qquad m + q\beta = \mathrm{B}.$$

Whence, by eliminating q, we have

$$m = \mathrm{A} - \alpha\left\{\frac{\mathrm{B}-\mathrm{A}}{\beta-\alpha}\right\}, \text{ or } = \mathrm{B} - \beta\left\{\frac{\mathrm{B}-\mathrm{A}}{\beta-\alpha}\right\}.$$

The "medians calculated" in the table below are thus derived. The simple interpolations require no explanation. Graduations on the scale 0° to ± 45° are in brackets.

	Values of b			
	(+20°) 70°	(+30°) 80°	(+40°) 90°	(+50°) 95°
a=20° (−30°)				
Medians calculated	348	300	259	236
Simple interpolation	340	300	271	260
a=40° (−10°)				
Medians calculated	231	193	167	154
Simple interpolation	233	200	180	173

The interpolated results are, of course, correct when A and B are symmetrically placed, as they are at 20° (−30°), and 80° (+30°). They are most incorrect when either A or B is near to the limits of the curve, and when both are on the same side of its middle point.

When applying the method practically, especially upon some unfamiliar characteristic whose law of frequency is doubtful, the determination of M should be considered as a first approximation, and the process be repeated with two new values A_1 and B_1, the one a little less, and the other a little greater than M. The new result M_1 could be accepted as final.

For perfection of simplicity some method, whether it be graphic or tabular, for converting observed numbers into percentiles, might be printed at the back of the blank form.

FRANCIS GALTON.

On the Cause of Dark Lightning and the Clayden Effect.

I HAVE been criticised in a letter which appeared recently in NATURE for not alluding in my letter on dark lightning to the peculiar photographic reversal known as the Clayden effect. I must confess that at the time of writing my letter I was unaware of this effect, a description of which has only appeared, so far as I know, in one of the photographic journals. Mr. Clayden has certainly explained dark lightning, and it only remains to explain his explanation. As I think that this effect is not generally known, I believe that it may be worth while to devote a few words to the statement of the case before describing the experimental work by which I have determined the factors which play a part in this very curious photographic phenomenon.

Mr. Clayden showed that if a plate which had received an impression of a lightning flash or electric spark was subsequently slightly fogged, either by exposing it to diffused light or by leaving the lens of the camera open, the flash on development came out darker than the background. If, however, the plate was fogged before the image of the flash was impressed, it came out brighter than the background, as in the ordinary pictures of lightning. I refer to the appearance in the positive print in each case. This is quite different from ordinary reversal due to the action of a very intense light, for the order in which the lights are applied is a factor, and the phenomenon lies wholly in the region of under-exposure. I repeated Mr. Clayden's experiment, and obtained dark flashes without any difficulty.

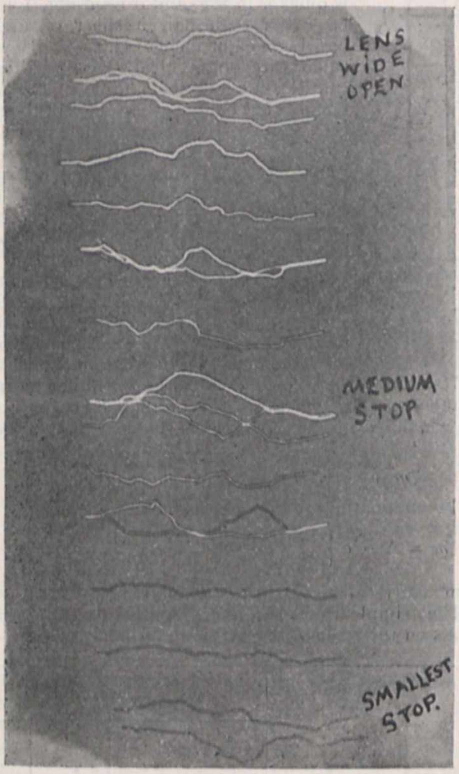


FIG. 1.

The effect cannot, however, be obtained by impressing an image of the filament of an incandescent lamp on a plate, and subsequently fogging the plate. Clearly there is something about the light of the electric spark which is essential to the production of the reversal. It is not intensity, however, for I found that it was impossible to obtain reversed images of bright sparks with the lens wide open.

Fig. 1 shows a series of spark images, some normal, some partly reversed, and others wholly reversed. The sparks are those of a large inductorium with a good-sized Leyden jar in circuit. The sparks were all of equal intensity, but after each discharge the iris diaphragm of the lens was closed a little. It will be seen that the borders of the bright sparks are reversed. In some the image is reversed, with the exception of a narrow thread down the core. The images were impressed in succession on the plate by moving it in the camera. A plate holder was dispensed with, an opening being made in the ground-glass back by removing a strip a few centimetres wide. The plate was held against this opening, and a large number of exposures made in a few moments. Of course, the room was in total darkness. After exposure, the plate was exposed to the light of a candle for a second or two, and then developed.

In this series of pictures it will be seen that the edges of the bright images of the sparks are reversed, the intensity on the border of the image being less than at the core. As the intensity of the spark becomes less and less, the bright central core dwindles down to a mere thread, and eventually disappears, the spark's image being feeble enough to reverse over its entire area.

This explains why the dark lightning flashes are usually

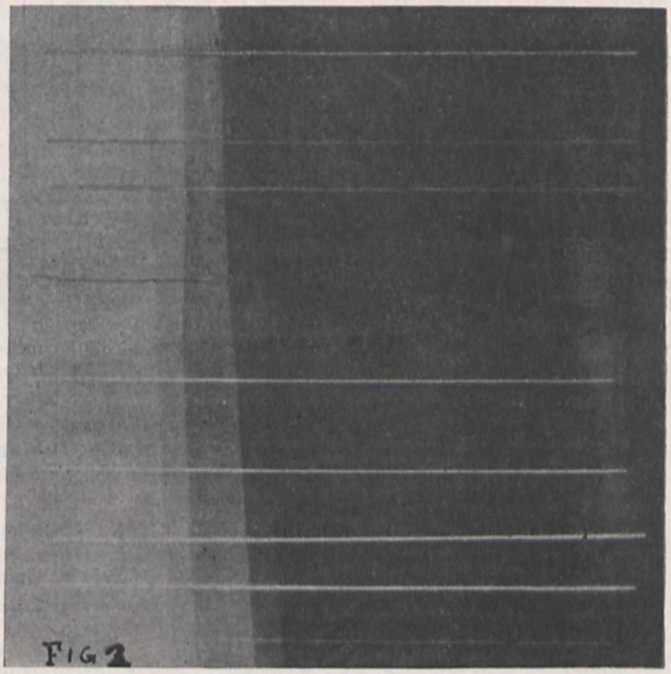


FIG. 2.

ramifications of the main flash. The ramifications are less brilliant discharges and reverse, while the main one is too bright to cause the effect.

The first thing that occurs to one is that it may be some peculiar radiation, which the spark emits, which is wanting in the light coming from other bodies. If a small photographic plate is partly screened by a piece of black paper and illuminated by the light of a small spark at a distance of two or three feet, and a similar plate, screened in the same manner, is illuminated for a moment by candle light of sufficient intensity to produce the same amount of blackening on development, we shall have the means of showing that the spark light differs in its action on the plate from that of the candle. If these two plates, before development, be half-screened in a direction at right angles to the former one, and exposed to the light of the candle for a second or two, the part of the plate which has been illuminated by spark light plus candle light does not become as black on developing as the part which has received candle light alone, whereas the part which has been twice exposed to candle light is blacker than that which has been only exposed once. This shows that the light of the spark does not act in the same way as the light of the candle. Wherein does it differ? It seemed possible that the peculiarity lay in the nature of its radiation. To test this a prism was placed before the lens of the camera, which broke up the image of the spark into a series of spark images of different colour. The plate was exposed to the flashed spectrum of a single spark, then removed from the camera and exposed to the candle light, and developed. If the reversing effect was due to any peculiar radiation or wave-length we should find the reversal at that part of the spectrum where the effective radiation belonged, say in the infra red if the reversing power lay in long waves given out by the spark. It was found that the entire spectrum came out lighter on the negative than the fogged background. A second plate was exposed to the spectrum flash, then slightly fogged, and a second spectrum impressed on it in a different place. On developing, one spectrum came out light and the other dark. Clearly the effect does not depend on wave-length. It then occurred to me that the time-element might enter into the problem. The light of the spark is over in about 1/50000 of a second, and it did not seem impossible that a bright light of exceedingly short duration might act quite differently on a plate from a weaker light of longer duration. This may be tested in a variety of ways. We may open the lens wide, impress the image of a single spark on the plate, and then stop the lens down and superimpose a number of spark images sufficient to make the total exposure the same in each case. This was the first method which I tried. In order to compel the successive sparks to pass over the same path, that their images might be superposed, I shut them up in a capillary tube. With the lens open wide enough to give the maximum reversing action, I passed a single discharge through the capillary. Stopping the lens down to one quarter of its former aperture, four discharges were passed through the tube. The plate was then fogged in the usual manner, and on development the single discharge was reversed, but the composite one was not.

Fig. 2 is from a plate showing this effect. The upper images are those of single discharges through the capillary, with different apertures of the lens; the lower images are those of double or triple discharges through the same tube. The left-hand side of the plate was exposed to the candle light for different amounts of time, by moving the screen over small distances during the exposure. Only the single discharges reverse, though the density of the images on the unfogged portion of the plate is the same.

This was very strong evidence that the duration of the illumination was the important factor. Some years ago I measured the duration of the flash of exploding oxy-hydrogen, finding it to be about 1/12000 of a second. Possibly the flash of such an explosion would duplicate the effect. I exploded several glass bulbs filled with electrolytic gas, but found that the action was the same as that of ordinary light, it being impossible to get any reversal. The flash evidently lasted too long, or there still remained some undiscovered factor.

The difference between the action of spark light and the light of the oxy-hydrogen flash is shown in Fig. 3.[1] Plate "a" shows the effect of the explosion flash. Squares 1 and 2 received the light from an exploding bulb, the rest of the plate being covered. Squares 1 and 3 were then exposed to the light of the candle. Square 1, which has received the light from both sources, is the brightest, that is, the effects are additive, there being no reversal. Plate "b" shows the action of the light from the spark. Squares 1 and 2 were illuminated by the spark light, then squares 2 and 4 were exposed to the candle. In this case, square 4, which was illuminated by the candle, is brighter than square 2, which received both the spark light and candle light. In this case the effects are not additive, there being reversal.

To demonstrate conclusively that the time-factor was the only one, it was necessary to secure an illumination independent of the electric spark, and of as short duration. This was accomplished in the following manner: A disc 30 cms. in diameter was furnished with a radial slit 1 millimetre wide near its periphery, and mounted on the shaft of a high-speed electric motor. A second slit of equal width was arranged close to the rim of the disc, in such a position that the two slits would be in coincidence once in every revolution. This second slit was cut in the wall of a vertical chute, down which a photographic plate could be dropped. By means of a large convex lens of short focus, an image of the crater of an arc-lamp was thrown on the point of coincidence of the slits. The intensity of the illumination transmitted by the slits when in coincidence was almost sufficient to char paper. The motor was now set in motion, and a plate dropped down the chute. On developing this plate, three images of the slit appeared, not at all over-exposed, though the plate was the fastest obtainable, and the intensity of the light while it lasted comparable to that at the focus of a burning glass. By measuring the distance between the images and the vertical distance through which the plate had fallen, it was an easy matter to calculate the speed of rotation, which was found to be sixty revolutions per second, the air friction of the disc preventing higher speed. The duration of the exposure will be the time occupied by the rim in travelling a distance equal to the width of the slit, or 1 mm. This was found to be 1/55000 of a second, about that of the spark. The crucial experiment now remained. A second plate was dropped, and, before development, was exposed to the light of the candle. *The images of the slit were most beautifully reversed*, except at the centre, where the light was too intense. It seems, then, that we are justified in assuming that *the action of an intense light on a plate for a very brief time-interval decreases the sensitiveness of the plate to light.* It is curious to contrast with this effect the fact that exposure to a dim light for a moment or two appears to increase the sensibility by doing the small amount of preliminary work on the molecules, which seems to be necessary before any change can be effected that will respond to the developer.

I am not prepared to say what the nature of the change effected by the flash is. Possibly some one familiar with the theory of sensitive emulsions can answer the question. I have tried using polarised light for the reversing flash, and then fogging one half of the plate with light polarised in the same plane, and the other half with light polarised at right angles to it. As was to be expected, there was no difference in the effects.

R. W. WOOD.

Physical Laboratory of the University of Wisconsin,
Madison, Wisconsin, October 20.

[1] The details in this figure, and in two others sent by Prof. Wood, are too indistinct to be reproduced satisfactorily.—ED. NATURE.

Experiments on the Floral Colours.

IN 1837 the illustrious Berzelius wrote: "The red pigment of several kinds of berries has generally been regarded as a blue pigment reddened by an acid. This is not the case with all berries. I have examined the pigment of *Prunus cerasus* and of *Ribes nigrum*, which contain the same pigment, and this is not blue. Probably this has been surmised from the circumstance that the sap of these berries gives a blue precipitate with acetate of lead, but these precipitates are malate and citrate of lead, wherewith the pigment is combined." He found that, after separating these acids from the colouring matter, the latter yields a green and not a blue precipitate with acetate of lead; and, moreover, when to its aqueous solution a little milk of lime is added sufficient to saturate all the free acid, the supernatant liquid is red and not blue, which latter it would be if its natural colour was blue. He arrives at similar conclusions with regard to the red pigment of the autumn leaves of cherry, red currant, &c.

On the other hand, Julius Wiesner, of Vienna, in 1862 and 1872, by a series of experiments, endeavoured to prove that the compounds of anthocyan—*i.e.* the blue and red pigment of flowers, with lead, alkalis, &c.—are always blue, and it is only when anthocyan is present in the cell-sap simultaneously with a substance which is coloured yellow by alkalis, &c., that it passes by the latter body into green, which thus arises as a mixed colour. He found that by completely washing out (as he thought) this latter body from the petals by warm dilute hydrochloric acid, and then immersing them in solutions of lead and iron salts, they became intensely blue; hence he was led to conclude, contrary to Berzelius, that the original and actual colour of anthocyan was blue and not red.

During last summer I have performed a series of experiments on a number of flowers, with a view of settling the question in dispute, as above set forth. In the first place, it was deemed advisable to observe the effect produced in each case by immersing the fresh petal into ether saturated with ammonia. The results were as follows:—(1) Petals which became blue, *e.g.* pæony, pink campion, deep red garden rose, sweet pea, vetch, mallow, balsam, geranium, fuchsia, scarlet rhododendron, crimson flax, blue centaurea; red daisy, periwinkle, lady's smock, became bluish-green. (2) Petals which became green, *e.g.*

anemone, larkspur, violet, willowherb, scarlet tropæolum, red rhododendron, bilberry, flowering currant, scabious, wild thyme, potato, forget-me-not.

The colouring matter was then withdrawn from these and other petals by macerating them for two days in cold methyl alcohol, the solution was poured off, evaporated to dryness, the residue taken up with warm water, and the solution after filtering tested as follows:—(1) One drop HCl or H^3PO^4, followed by several drops of ammonia; (2) solution of acetate of lead followed, or not, by acetic acid; (3) solution of acetate of magnesium. The results are tabulated as follows:—

Name of flower.	Natural colour.	HCl and NH^3.	Acetate of lead.	Acetate of Magnesium.
Pæony	red	deep blue-green	bluish-green	blue-green
Larkspur	blue	green	green	blue
Anemone	red	green	green	—
Violet	violet	nearly blue	green	dark blue
Oriental Poppy ...	scarlet	blue flush	green	green
Campion	pink	blue at neutral point	—	—
Ragged Robin ..	red	blue-green	green (blue, acid)	green (blue, acid)
Garden Rose ...	deep red	blue	bluish-green	green
Dog Rose ...	pink	green	green	green
Pyrus japonica ...	crimson	dark green	bluish-green	—
Clover	red	green	green	green
Vetch	red	blue	blue	—
Vicia sepium ...	red	green	green (blue, acid)	—
Sweet Pea ...	red	blue-green	green (blue, acid)	green
Mallow	red	blue	green (blue, acid)	—
Fuchsia	red	blue	blue-green (blue, acid)	green
Geranium ...	red	blue	red-purple (blue, acid)	red-purple
Flax	crimson	blue	blue	green
Flowering Currant	red	green	green	green
Daisy	red	dark-green	green (blue, acid)	—
Dahlia	deep red	blue	green (blue, acid)	green (blue, acid)
Scabious	blue	green	green (blue, acid)	green
Betony	red	green	green	—
Rhododendron ...	pink	dark green	dark green	deep green
Primula	red	green	green	—
Periwinkle ...	blue	blue-green	green (blue, acid)	—
Foxglove... ...	red	green	green	—
Snapdragon ...	red	green	green	—
Hyacinth... ...	blue	blue flakes	green (blue, acid)	green (blue, acid)
Tulip	red	red-brown	green	deep blue postea
Orchid	red	pure blue	green (blue, acid)	green (violet-blue, acid)

In a few cases the aqueous solution of the pigment, after acidification by HCl, was shaken up with amyl alcohol, and after allowing to separate, the lower acid liquid was withdrawn, and tested with excess of ammonia and of acetate of lead. In this way, rhododendron, red daisy, red tulip, violet, foxglove, *Vicia cracca*, red poppy, gave a brilliant pure blue coloration; while, on the other hand, flowering currant and woundwort gave greens with ammonia, but blue precipitates with acetate of lead. In order, however, to purify the pigment still more thoroughly, its alcoholic or aqueous solution was shaken up at intervals for two days with well-washed hide-powder, and the latter, after filtering off the liquid, was well washed and extracted with very dilute HCl. The bright red liquid thus obtained was treated successively with the aforementioned reagents. The result was extremely interesting; for while flowering currant and rhododendron gave greens, red tulip and purple orchis gave blues. In some cases the Wiesner's experiment was repeated, *i.e.* the fresh petals were warmed with dilute HCl, and the acid quite washed out with water, and the now reddened organs placed into solutions of acetate of lead and acetate of zinc, when rhododendron, flowering currant, violet (in some cells), foxglove, *Vicia cracca* (in some cells), became green; while, on the contrary, *Geranium pratense*, bugle, the rest of the cells of violet, and of *Vicia cracca* became blue. It was evident, therefore, that Wiesner's opinion that anthocyan is invariably blued by alkalis, &c., and never greened, was not confirmed; inasmuch as at least three petals, when treated in the manner he prescribed, were distinctly greened, the presumption being that all yellow intermixture had been obviated.

The general conclusion which I think must needs be drawn from these my experiments is, that there are different stages in the development of the floral pigment. In the lower stages the natural colour is red, whatever the chromogen may be; and so far Berzelius was right. In the higher stages, on the other hand, the natural colour of anthocyan is blue, or rather (at least with some chromogens) it becomes capable of forming blue compounds or lakes with alkalis and certain metallic salts. Moreover, as I have laboured to show elsewhere, chromogens exist which, except under very exceptional conditions and circumstances, are incapable of producing a blue pigment; and these in all stages naturally develop into a red, the brilliancy of which, when contrasted with that of a blue accidentally obtained in an allied species (*e.g.* in flax), unequivocally attests its real, original, and proper character. P. Q. Keegan.

The Colour of Flints.

An examination of the pebbles lying on the beach of the coast of the English Channel shows that while these are principally flints they vary considerably in colour.

The flints derived from the chalk cliffs surrounding this part or the coast, and from which the shingle is generally supposed to be derived, are, so far as my experience goes, invariably black, with a white coating on the exterior.

Only about one-third of the flints on the beaches of such localities as Eastbourne, Hastings, Brighton, Hythe, Folkestone, Dover, &c., or in the large accumulations at Dungeness and at the Chesil Beach are apparently derived from the adjacent chalk cliffs, the remainder being different shades of brown, grey, white and red, the former being the most prevalent. In some cases the outside coating is of a different colour to the interior of the pebble. It follows, then, either that the flints from the chalk undergo some chemical action, either internally or externally, while exposed to the air and salt water of the beach, which changes their colour, or the majority of them must have been derived from inland gravels.

The first theory does not seem feasible, as flints are to be found in raised beaches and other positions, where they have been deposited for long periods, still retaining not only their interior black colour, but also the white coating on the outside.

If these various coloured beach flints are derived from inland gravel beds, they must have been deposited under different conditions from those which now prevail, as there is no action in operation on the south coast which can convey the flints from inland to the sea. The age of some of these shingle beds must, therefore, be much greater than has been generally supposed.

There are isolated pockets of gravel at the top of the chalk cliffs in some places, which fall on to the beach where the cliffs are eroded by the sea; but these are too few in number to account for immense deposits such as those at Dungeness, Pevensey and Chesil.

Failing to obtain any light on this subject from geologists to whom I have mentioned the matter, and whose opinions vary as to the changes flints undergo, I venture to appeal to Nature for a solution. W. H. Wheeler.

Boston, Lincs., November 27.

THE PROPOSED CHANGES IN THE MATHEMATICAL TRIPOS.

The Cambridge Board for Mathematics has presented to the Senate a report on the Mathematical Tripos. This report recommends certain changes in the regulations relating to that Tripos. The following note contains an abstract of the proposals made by the Board:—

The schedule of subjects for Part I. of the Tripos has been reduced by the entire omission of some subjects (calculus of variations, elliptic functions, Bessel's functions, hydrodynamics, sound). Other subjects have been limited in extent (*e.g.* rigid dynamics, electricity, optics, astronomy and others). Care has been taken to specifically exclude parts of some subjects. The arrangement of papers is to be entirely changed and no papers are to be exclusively devoted to problems. At the present time particular methods are prohibited in answering the questions set in certain papers; such general restrictions of methods are no longer to be maintained. A special regulation provides that at least half the questions set throughout the examination shall be of an elementary character.

The Board also proposes to abandon the custom of publishing the list of successful candidates in order of merit, and to follow the method at present adopted in the Classical Tripos. There will be three classes (Wranglers, Senior and Junior Optimes), and each class will consist of three divisions, the names in each division being arranged in alphabetical order.

The proposed changes in Part I. have involved some corresponding changes in Part II. The class-list is to consist of three divisions only, the names in each division being arranged alphabetically; and it is to be possible for a candidate to obtain a place in the first division in two ways. He may do so (as at present) by showing special proficiency in one section of the schedule of subjects, together with general proficiency in one or more other sections; or by showing general proficiency over a wider range of subjects.

The Board hopes that these changes will induce more men to take Part I. in their second year; it is at present possible to do so under a regulation which came into force in 1893, but very few have actually availed themselves of the rule (probably not 1 per cent. of the whole number of candidates since 1892). This is partly due to the fact that 90 per cent. of the candidates cannot cover the whole range of reading in two years, and partly to the natural desire of the more able men to appear in as high a place as possible in the list. By taking the Tripos in their second year, men who intend to study subjects such as physics or engineering will be able to gain a preliminary knowledge of mathematics, with indications as to how to extend their knowledge in any special branch which they may need in their future course. The second year Tripos will be of advantage also to the better mathematical men, who now spend half their third year in revision and in acquiring facility of solving artificial problems. Under the proposed regulations these men will have two years after Part I. (instead of one) in which to become acquainted with the ideas and methods of modern mathematics. This will be of special advantage to men who intend to devote themselves to mathematical research.

It is thought that the abolition of order of merit will assist the aims of the Board by making it possible for the papers to be easier, and by helping to remove artificial problems; and also by inducing a greater number of men to take the Tripos in the second year of residence. It is further felt by many that the proposed Part I. is not of sufficient extent to even profess to classify the candidates in an exact final order of merit.

On November 23 the proposals of the Board were discussed by the Senate. As might be anticipated, the scheme was criticised at some length, and particularly the proposal to abolish the order of merit. The Board will now revise its suggestions in the light of the criticisms of the Senate, and the Senate will have to vote on the final recommendations of the Board.

It seems that the present Tripos must be modified in some way, as the number of candidates has been steadily falling off in recent years. Though once the largest Tripos in the University, the Mathematical Tripos is now smaller than both the Natural Science and the Classical Tripos. Taking an average of the candidates for the four years 1869-72, we find that, of the resident undergraduates, one in eighteen passed the Mathematical Tripos; while for the five years 1895-99, the average falls to one in thirty-five (of course, this relates to Part I. only).

THE RESISTANCE OF THE AIR.

THE mportance of determinations of the resistance of the air to moving bodies, in connection with the problem of aërial navigation and numerous other practical applications, has led the Société d'Encouragement pour l'Industrie Nationale to offer a prize for investigations of an essentially experimental nature dealing with the reactions on a surface moving through the air under varying conditions as to form and velocity. One series of experiments with this object has been undertaken by M. l'Abbé Le Dantec, and a second set by M. Canovetti. The following account of these researches is based on the papers communicated by their authors to the *Bulletin* of the Society, and the report on them by M. Barbet.

The method adopted by M. l'Abbé Le Dantec is very simple, and had been used in some previous experiments by him in 1893. It is based on the property that the motion of a falling body is at first accelerated, but the resistance of the air, increasing as the velocity increases, soon balances the weight of the body, and the body thus soon acquires its terminal velocity, and then moves uniformly. The resistance of the air at this velocity is exactly equal to the weight of the falling body.

In the present experiments the surface whose resistance is to be observed slides down a vertical wire, which acts as a guide without introducing perceptible friction. Its weight and area can be easily and accurately measured; and Le Dantec has now devised an electric recording apparatus, which enables the time of fall to be estimated with equal precision. A band of paper is unrolled by clockwork action, and on this band an electric arrangement records the vibrations of a seconds pendulum. Furthermore, when the falling surface is released, a current is started whereby a toothed wheel is brought into contact with the paper band, and traces on it a dotted line. The surface at the end of its descent comes in contact with a buffer, the current is broken, and the cessation of the dotted line indicates the exact instant at which the surface reached the buffer. The operator can vary the height in such a way that the descent occupies one, two, three or more seconds, and by subtraction the distances traversed in each successive second are obtained.

The experiments were conducted in the chapel of the Conservatoire des Arts et Métiers, the nave of which is of considerable height, and their accuracy is verified by the perfect agreement of the results. Thus several experiments conducted for the purpose of determining the height through which a surface fell in a certain number of seconds agreed to within a centimetre. The chief conclusions are as follows:—

(1) Even feeble air currents such as are produced by persons moving about in the neighbourhood of the apparatus suffice to considerably modify the results, and it is important therefore that the experiments should be conducted in a closed building, which must, however, be sufficiently large for the walls not to materially affect the stream-lines of the air flowing past the moving surface.

(2) A square surface 1 metre square, moving with a velocity of 1 metre per second, experiences a resistance of 81 grammes.

(3) Experiments conducted with three different surfaces, each of 1 square metre in area, but of different forms, viz. circular, square, and of the form of an equilateral triangle, respectively, show that the resistance depends on the form of the surface, and the results accord with the hypothesis that the resistance of a surface of given area is proportional to the length of its contour. This property appears to be new.

(4) For velocities varying within certain limits, the law of proportionality of the resistance to the square of the velocity was verified.

The resistance of the air to a moving surface can also be measured by attaching the surface to a small truck which is allowed to descend an inclined plane under gravity. If there were no resistance to motion the square of the velocity at any point would be equal to twice the product of the vertical height fallen into the acceleration of gravity, but since friction and atmospheric resistance retard the motion, and the latter resistance increases with the velocity, the truck soon acquires its terminal velocity, and in the uniform motion which follows, the total resistance is equal to the weight of the moving body resolved down the plane. By experimenting with the truck alone, the resistance experienced by it can be obtained separately, and by subtraction the portion of the resistance due to the surface under observation is found.

This method forms the basis of M. Canovetti's experiments. Instead, however, of an inclined plane, a copper wire was employed, three millimetres in diameter and 370 metres in length, of which one end was fixed on the side of a hill, and the other on the level ground at its base. This arrangement is similar to that used in many countries where bundles of wood are sent down from the hills by means of a wire. Owing to the wire hanging in a catenary, the lower part of the wire was much less steeply inclined than the upper, the wire even sloping upwards near its lower extremity. For this reason Canovetti did not take into account the last ninety metres of the path.

The mode of suspending the various surfaces by a trolley is shown by the accompanying figures. The wheels of the trolley were provided with ball bearings. In order to determine what part of the resistance was due to the trolley itself, the latter unloaded was allowed to descend a wire at an inclination considerably smaller than that employed when it carried one of the surfaces, the smaller resistance of the unloaded trolley rendering a reduction of the gradient necessary in order that the resistance might be calculated under similar conditions as to velocity. The experiments indicated that the resistance of the trolley alone was proportional to the velocity.

In determining the velocity, Canovetti contented himself with reading on a chronometer the instant of starting the trolley and the instant at which it passed a mast placed 90 metres in front of the stopping point. By dividing the 280 metres traversed by the time occupied between the two readings, the average velocity of descent was obtained, and this average velocity formed the basis of Canovetti's conclusions.

The most interesting of these results are those referring to the relative resistances of circular and rectangular planes, and the effects of attaching a cone or hemisphere to a circular disc forming a bow or stern. Canovetti finds that the resistance of the air on an area of one square metre moving with a velocity of 1 metre per second is 90 grammes for a rectangle and 80 grammes for a circle.

A right cone, whose altitude is 1·5 times the diameter of its base, attached to the rear face of the circle reduces the resistance to 60 grammes.

A hemisphere placed in front of the circle as a prow (Fig. 1) reduces the resistance to 22·5 grammes.

Finally, in a double cone, formed by placing a cone of altitude double the diameter of the base in front of the circle, and a cone of altitude equal to the diameter of the base behind (Fig. 2), the resistance is reduced to 15 grammes, or less than a fifth of the original resistance.

Canovetti made a series of further experiments on solids resembling in form the Chalais balloon by suspending a cone and hemisphere, joined by their bases in a net (Fig. 3). In one of these observations the resistance was equal to 80 grammes. This high resistance was due largely to the net, but also in part to the instability of motion, which caused the whole model to undulate. In proof of this latter influence experiments were separately made on models rigidly attached to and freely suspended from the trolley. By taking a model formed of a cone and hemisphere, and attaching it to the trolley by rigid supports fixed one near the common base and another near

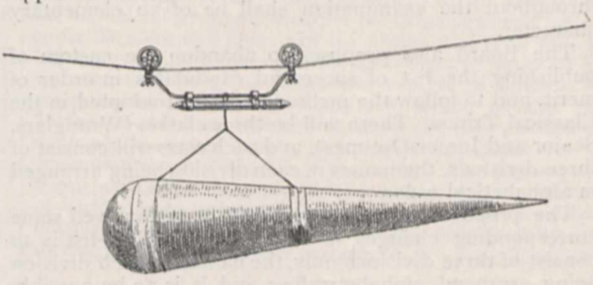


FIG. 1.

the vertex of the cone, a coefficient of resistance equal to one-seventh of that of the corresponding circular disc was obtained.

To sum up, then, Le Dantec's experiments appear to have been conducted with every precaution to secure

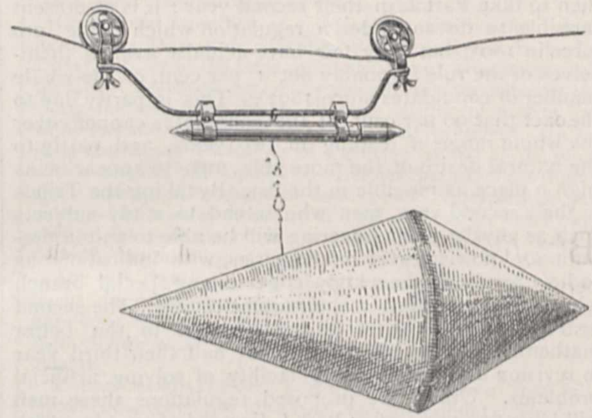


FIG. 2.

accuracy. The coefficient of resistance which he calculates from determinations made in a room from which draughts are carefully excluded must be regarded to some extent as the limiting value of a physical constant ob-

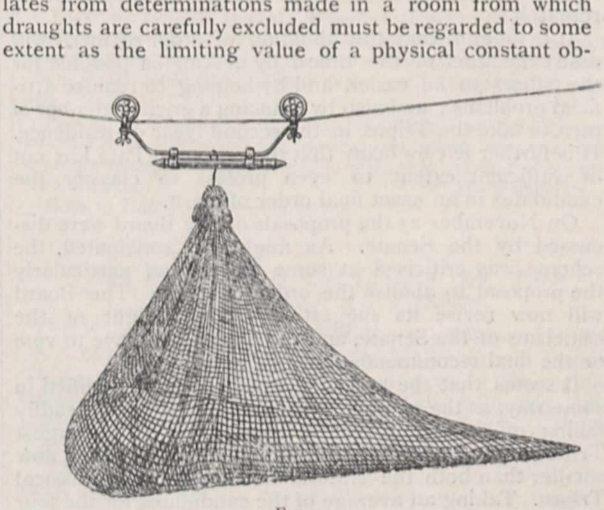


FIG. 3.

tained under conditions which are difficult to realise in practice. We may compare such determinations, *e.g.* with the determination of the weight of a cubic centimetre of absolutely pure water, since in all probability a large volume of air free from all currents and a cubic centimetre of water free from all impurities, are both of them well-nigh equally difficult of realisation. The exact determination of such constants is nevertheless of the greatest scientific interest, and even the difference between their values and those obtained under more normal conditions affords a measure of the allowance that must be made for the discrepancies which exist between theory and practice.

Canovetti's experiments, on the other hand, are essentially of the rough and ready order in several respects. The wire hanging as it does in a catenary, the differences of inclination at different parts of the course render the motion far from uniform over the 280 metres, and the estimated velocities can only be regarded as average velocities in a motion with variable velocity, the details of which have not been fully investigated. A further source of error is due to the sagging of the wire at the point where the trolley rests on it, and the consequent absorption of energy in producing vibrations. It is thus not surprising to find that Canovetti obtains 90 grammes for the resistance of a rectangle where Le Dantec finds 81 grammes; one might not unreasonably have expected a greater discrepancy. Although Canovetti avoided windy days, yet his experiments were conducted in the open air under conditions which might be regarded as normal in ordinary calm weather, and so far as the results bear on the question of the relative efficacies of different forms of balloons and other bodies in overcoming air resistance, they may be regarded as furnishing data of considerable practical value. G. H. BRYAN.

DR. HENRY HICKS, F.R.S.

BRITISH geology suffers a severe loss in the death of Dr. Henry Hicks, a loss which will long be felt on personal as well as scientific grounds. His chief work was in South Wales, among the older Palæozoic formations, whose life-history was previously but little known. He pushed his inquiries into the very oldest pre-Cambrian rocks, both in Wales and Scotland; and then turning from these most ancient records he gave attention to those immediately preceding the present order of things, and pursued with equal ardour the evidences of glaciation in South Wales and Middlesex, the records of old bone-caves, and the remains of mammoth in the Thames Valley. No man had a keener eye for fossils. To him rocks which had for long been deemed unfossiliferous yielded up some evidences of life.

Now and again his enthusiasm led him to draw conclusions and express opinions that were too slenderly supported by evidence, and consequently he was brought perhaps more than any other man of his time into active conflict on the battle-field of geology. No one, however, seemed to enjoy more heartily the animated debates which his own papers so often provoked than Dr. Hicks.

Henry Hicks was born at St. David's, in Pembrokeshire, in 1837, and was educated at the Collegiate and Chapter School in that city. Coming to London to study for the medical profession, he entered Guy's Hospital, and was admitted a Member of the Royal College of Surgeons and a Licentiate of the Society of Apothecaries in 1862. Returning then to his native place he commenced a practice which he continued until 1871, when he removed to Hendon. He now devoted special attention to mental diseases, took the M.D. degree at St. Andrews in 1878, and continued his active and useful medical work until the close of his life.

It was in 1863, while resident at St. David's, that Dr. Hicks' attention was first attracted to geology, and the inspiration came through the late J. W. Salter, then palæontologist to the Geological Survey. In the previous year Salter had himself discovered, for the first time in Britain, remains of the large Trilobite *Paradoxides*, which was then stated to occur in the "Lower Lingula Flags," of St. David's. Dr. Hicks' interest was aroused; he diligently commenced to search for fossils among the old rocks around him, and as he himself has told, the enthusiasm with which every new find was welcomed by Salter, "to whom they were first sent, was in itself a sufficient stimulus for any exertions required." A grant in aid was received from the British Association in 1863, and in the following year Salter was enabled to report at the Bath meeting that the energetic work of Dr. Hicks "has already brought to light more than thirty species of fossils, most of them Trilobites"; and as he elsewhere remarked, these discoveries "made a large addition to the Primordial fauna."

With the help and encouragement thus given by Salter Dr. Hicks pursued his work with unflagging devotion. His first communication to the Geological Society was made in 1865, and dealt with the genus *Anopolenus*; and from that date onwards for some years he contributed a series of most important papers on the stratigraphy and palæontology of the Cambrian and Lower Silurian rocks of South Wales, two or three of the earlier papers in conjunction with Salter or Robert Harkness. These researches led to the establishment of the Menevian group in 1865 by Salter and Hicks for part of the Middle Cambrian division which is characterised by *Paradoxides Davidis* &c.

In 1876 he communicated a more particular account of the pre-Cambrian rocks of Pembrokeshire, and here he came perhaps more into conflict than on any previous occasion. The granitoid rock which he named Dimetian and claimed as pre-Cambrian was regarded by Sir A. Ramsay as metamorphosed Cambrian, and afterwards by Sir A. Geikie as a granite mass intruded into the Cambrian rocks. The Pebidian volcanic series, also regarded as pre-Cambrian by Dr. Hicks, was grouped with the Cambrian by Sir A. Geikie. The evidence for a third and intermediate series named Arvonian by Dr. Hicks was subsequently admitted by him to be inconclusive. In his views concerning the antiquity of the Dimetian, Dr. Hicks was strongly supported by Prof. Bonney, Prof. Hughes and Mr. Thomas Davies. With regard to the Pebidian, it is now recognised that the beds are of the type of the Uriconian of Shropshire, generally classed as pre-Cambrian.

Between 1878 and 1883, Dr. Hicks published a series of papers on the metamorphic and overlying rocks of parts of Ross-shire and Inverness-shire, with petrological notes by Prof. Bonney and Mr. T. Davies.

Since he went to reside at Hendon, Dr. Hicks gave much attention to the local geology, and recorded many facts of interest. In course of time the subject of bone-caves greatly occupied him, and Cae Gwyn Cave in particular was explored in company with Mr. E. B. Luxmoore and others. It was then shown that this Denbighshire cavern was occupied by an early Pleistocene fauna and by man before the deposition of any of the local glacial deposits.

In 1890 Dr. Hicks bent his steps into North Devon, and was much struck with the evidences of folding, faulting and crushing near Ilfracombe. He then for the first time found a *Lingula* in the Morte Slates, and expressed the opinion that these rocks were older than the Devonian. Working zealously in Devonshire, and re-visiting South Pembrokeshire for the sake of comparisons, he elaborated his views in 1896 and 1897. He had now succeeded in finding a number of fossils in the Morte Slates and in different localities, but whether these were in part true Silurian fossils as maintained by Dr. Hicks and the Rev. G. F. Whidborne, or wholly Lower Devonian, Dr. Hicks had clearly shown that the succession across North Devon was not continuous and unbroken as had been supposed. The discovery of the fossils was indeed a grand one, and it indicated also that the Morte Slates "vary considerably in different areas, and probably include beds of very different age."

These, his last researches, were carried out with all the enthusiasm of his earlier work, and when first announced to the Geological Society they roused as much opposition. The fact is that when he read the first paper only one *Lingula* had been found in the Morte Slates, and it was felt that the conclusions drawn by the author were not justified. Undaunted, he returned again and again to the field; he reaped a rich harvest where others had altogether failed, and if he did not succeed in demonstrating that Silurian rocks occur in North Devon, he at any rate made manifest that until better preserved fossils are obtained it is not safe to say they are not there.

Dr. Hicks became a Fellow of the Geological Society in 1871; for many years he served on the Council, he was one of the honorary secretaries from 1890-93, and president from February 1896 to February 1898. The Bigsby Medal was awarded to him by the Council in 1883. Dr. Hicks had also been President of the Geologists' Association, 1883 to 1885. He was elected a Fellow of the Royal Society in 1885. In his busy professional life he found geology a "means of recreation and of much intellectual enjoyment"; and until near the close of his life he maintained a youthful energy and vivacity, and looked the picture of health. To his many friends the sad tidings of his death at Hendon on November 18, at the age of sixty-two, came as a surprise, and everywhere raised feelings of the utmost sorrow.

H. B. W.

NOTES.

THE sum of fifteen thousand marks appears in the Budget of the German Imperial Home Office as Germany's contribution towards the preparation of an international catalogue of science.

THE *Electrician* states that a school for wireless telegraphy is being established on one of the Government hulks in Portsmouth harbour.

M. DE COPPET has forwarded to the treasurer of the French Physical Society a cheque for 1000 francs towards meeting the expenses of printing the "Receuil des Constantes Physiques."

AT the annual meeting of the Royal Institution of Cornwall held at Truro on November 21, under the presidency of the Rev. S. Baring-Gould, the Henwood Gold Medal was presented to Mr. Rupert Vallentin for his observations on the fauna of Falmouth, accounts of which are published in the last three numbers of the *Journal* of the Institution.

THE Walsingham Gold Medal of the University of Cambridge has been awarded to Mr. H. H. W. Pearson, Assistant for India in the Kew Herbarium. This medal is obtained by competition in original essays on any branch of biological science. Mr. Pearson's essay was on the botany of the Ceylon Patamas, recently published in the *Journal* of the Linnean Society.

PROF. KARL PEARSON, F.R.S., will deliver a lecture entitled "Matter and Motion" in the chemical theatre of University College, Gower-street, on December 6 at 5 P.M. The members of the Chemical and Physical Society invite the presence of all who are interested in the subject.

THE fourth international congress of psychology will be held at Paris, in connection with the international exhibition, on August 20-25, 1900. It is hoped that all who are interested in the study of psychology in its various aspects will take part in the congress. The general secretary is Dr. Pierre Janet, Rue Barbet-de-Jouy 21, Paris, to which address all communications concerning membership should be sent.

WE regret to learn, from the *Botanisches Centralblatt*, of the death of Prof. P. Knuth, at Kiel, on October 30, in the forty-fifth year of his age, shortly after his return from a long journey. Dr. Knuth had worked on the same lines as the late Dr. Hermann Müller, in collecting an immense amount of information respecting the visits of insects to flowers and their agency in cross-fertilisation. Only last year he published the first and second volumes of his "Handbuch der Blütenbiologie," in which every observation of importance made by himself or others recorded during the last quarter of a century, since the publication of Müller's "Befruchtung der Blumen," is collated. A third volume remained unpublished at the time of his death.

IT appears from a detailed article in *Engineering* that the British display at the Paris International Exhibition next year will be quite unworthy of the manufacturing power of this country. This, we need hardly remark, is a matter for deep regret, especially as our chief competitors are arranging for exhibits on a very large scale. The German display will be of the first magnitude. Thus the German exhibit in the group of appliances and general processes relating to literature, science and art, will be contained in a separate pavilion, the contents of which will be valued between three and four million marks. In the group devoted to decoration of buildings, furniture, &c., the value of exhibits is estimated at 150,000*l*., and a similar value is set on Germany's electrical exhibits. The value of exhibited general machinery is stated to be 35,000*l*.; agricultural exhibits 20,000*l*.; the naval and military exhibit 30,000*l*., and so on. The total value of German exhibits is estimated at a million sterling. British industries and science will only be represented by 642 exhibitors. Referring to the inferiority of the representation of Great Britain at the Exhibition in comparison with other countries, *Engineering* remarks: "Manufacturers best know what are their own interests, and they have presumably come forward in such small numbers only after careful consideration. Possibly this apparent indifference is partly due to the remarkable absence of information available about the Exhibition, and partly because of the unsatisfactory arrangement, from an exhibitor's point of view, by which exhibits will be scattered over a large area, instead of being concentrated into a British section. But whatever the causes, we must be prepared to meet our chief competitors in as many thousands as we number hundreds; if manufacturers are then disappointed, they will only have themselves to blame. One reason of our inferiority in numbers is, no doubt, to be found in the antipathy of the British industrial to co-operate in industrial exhibits. He stands alone in this prejudice, and has, of course, to pay the penalty."

THE claims of inorganic chemistry to increased attention have recently been urged in Germany on two important occasions. Addressing the Naturforscher-versammlung at Düsseldorf last year, Prof. van 't Hoff gave a most interesting review of the recent achievements of inorganic chemistry, and made a strong plea for the cultivation of this branch of the science. This plea has been put in a more concrete form at the Göttingen meeting of the German Electrochemical Society. The subject was introduced on this occasion by Prof. W. Hittorf, and the proceedings culminated in a letter addressed to the Minister of Education asking definitely for the establishment of professorships and laboratories for inorganic chemistry.

PROF. HITTORF points out how largely German chemists have deserted inorganic for organic chemistry; how, with the exception of the late Victor Meyer, hardly an organic chemist of the later school has made important contributions to inorganic chemistry; how at the present time only two of the largest Universities and one Hochschule have independent professors of the subject. He urges the cultivation of inorganic chemistry not only in the interests of technology, but from the conviction that the study, especially in relation to electro-chemistry, will give a deeper knowledge of the nature of chemical combination, and so strengthen the foundations of the whole science. He would not in the least deprecate the study of organic chemistry, but maintains that at present inorganic chemistry is in the position of a cinderella.

A NUMEROUS and influential deputation waited upon the Town Council of Edinburgh last week to urge the Corporation to give their influence towards the promotion of the movement for the establishment of a zoological garden in Edinburgh. Prof. Cossar Ewart described the advantages of zoological gardens, and pointed to what was being done to establish and carry on such institutions in the British Isles and elsewhere. Such an establishment in Edinburgh would be very valuable for the advancement of biological science, besides being a constant source of recreation and instruction to the public. Prof. Ewart remarked that though the climate of Edinburgh might not equal that of Dublin, it is better than that of Amsterdam, where there is a flourishing if not a very large zoological garden. The expenditure in Dublin is 3000*l*., while the income, including a Government grant, is just over 3000*l*. When it is borne in mind that some 10,000*l*. or 12,000*l*. was raised in four days in connection with the recent show of the Highland Society in Edinburgh, the raising of 3000*l*. annually should not prove insuperable. Among other advantages, a zoological garden would prove a very valuable addition to the educational institutions of Edinburgh. The chairman of the School Board of the city, who was a member of the deputation, supported Prof. Ewart in this view, and pointed out that a zoological garden would be particularly valuable in connection with object lessons in natural history. In replying to the deputation, the Lord Provost said that the Corporation could not embark at the present time upon any large capital expenditure, but asked the deputation to consider what the Corporation should do in support of the movement.

IN connection with the subject of the foregoing note, the account of the New York Zoological Park given in *Forest and Stream* is of interest. This establishment was opened on November 8, at South Bronx Park, New York, and is the largest zoological garden in the world. The well-known Zoo of London has an area of 30½ acres; that at Amsterdam of only 25; that of the Société d'Acclimitation at Paris of 50 acres; that at Berlin of 60. In the United States the Philadelphia Zoo occupies 33 acres, the Cincinnati Zoo 36, while the National Zoological Park at Washington, maintained by the U.S. Government, and with an area of 168 acres, has until now been the largest zoological garden in the world. The New York Zoological Park, however, is more than one-half larger, covering 261 acres. The new park belongs to the New York Zoological Society, which was incorporated by a special act of the Legislature with purposes to establish and maintain a zoological garden in the city of New York, to encourage the study of zoology, and to furnish instruction and recreation to the people. As a condition of the grant of South Bronx Park and the maintenance of the collections and the park by the city, the Zoological Society was required to raise 250,000 dollars, of which amount 100,000 dollars was to be in hand before the society entered into occupation of the park. This fund was to be expended in the erection of the necessary buildings and inclosures, and in the purchase of collections, as well as for the general purposes of the society, but as stated, the city was to prepare the ground of the park, to maintain it in good order and to bear the expense of caring for the collections. The 100,000 dollars were raised by the New York Zoological Society, and in July, 1898, ground was broken. Recently the last touches were put on the more important buildings that have been erected. The animals began to arrive a few weeks ago, and the number already received is very large, although, of course, as yet only a beginning has been made.

THE Berlin correspondent of the *British Medical Journal* states that on the occasion of Prof. Rudolph Virchow's jubilee—the fiftieth anniversary of his tenure of office as professor ordinarius—the Senate of the University, with its rector, Prof. Fuchs, at their head, assembled to greet their revered and honoured colleague, and to present an illuminated and illustrated address, the text of which had been written by Prof. Waldeyer. In it Virchow's wonderful many-sidedness, and his achievements as investigator, archæologist, and politician were recounted in glowing terms. Prof. Virchow, who was surrounded by his family and many personal friends, in his reply gave expression to his thanks for the support which he had always met with on the part of the university, and said it was true that his chief feeling had ever been that of "the professor." In cases of conflicting interests he had always chosen the course of "professor." In the evening the Berlin Medical Society did homage to its president (Prof. Virchow) by a graceful little spontaneous ceremony. The presidential chair was wreathed and decorated with flowers and garlands, and the vice-president, Prof. v. Bergmann, greeted Prof. Virchow with a speech full of hearty good feeling, respect and admiration.

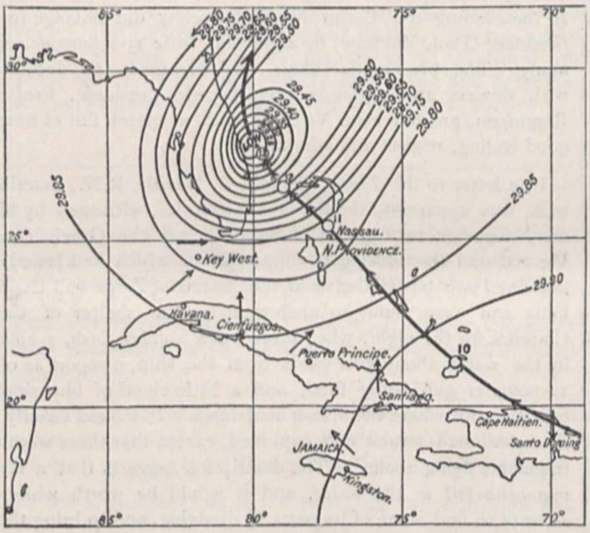
IN a letter to the *Times*, Captain G. Neville, R.N., describes what was apparently the fall of a meteorite, witnessed by him on November 19 from H.M.S. *Dido*, off the Greek coast. He remarks that during a thunderstorm which had lasted all the day "we passed between the islands of Zante and Cephalonia and were about to anchor under the shelter of Cape Clarenza for the night, when there was a sudden flash, a splash in the water about 100 yards from the ship, a report as of a 12-pounder gun being fired, and a little cloud of blue smoke over the spot where the splash had been. It looked exactly as if a shell had struck and exploded, except that there were no fragments flying about." The description suggests that a large meteorite fell in the water, and it would be worth while to attempt to find some of its parts by dredging, and to bring them to the surface.

THE following announcements are made in *Science*:—Dr. Samuel W. Stratton, associate professor of physics in the University of Chicago, has been appointed director of the Bureau of Weights and Measures, United States Coast and Geodetic Survey.—The Rumford Committee of the American Academy of Arts and Sciences has made a grant of five hundred dollars to Prof. E. B. Frost of the Yerkes Observatory, to assist in the construction of a spectrograph especially designed for the measurement of stellar velocities in the line of sight.

THE *Pioneer Mail* states that the Commission appointed to consider the advisability or otherwise of forming an Agricultural Department for Ceylon has reported favourably upon the formation of an agricultural department. It is recommended that the department should be combined with the irrigation department. Further, the Commission has recommended the appointment of four experts to be attached to the department—an entomologist, a cryptogamist, a chemist and a veterinary surgeon. The connection of the Botanical Gardens with the proposed department is not very clear; but it is understood that it will also come under the department, as will the Agricultural School.

REFERRING to the subject of standard time, Prof. Cleveland Abbe remarks in the U.S. *Monthly Weather Review*:—"Our international commercial intercourse will become precise only when we adopt Greenwich dates and Greenwich time throughout the world. This improvement, conducing as it does to the transaction of daily business, will not injure but rather be helpful to meteorology. No one has ever attempted to plot upon an ocean chart the observations of a storm by a hundred vessels at sea, but has found inextricable difficulty with records that are kept by the rules of the ancient navigators; the trouble is with the date of the month and day of the week. The modern navigator and the modern business man will do well to think, speak, and write of Greenwich days and dates only, if he would attain precision in current history."

THE West Indian hurricane of August 7–14 is described by Prof. E. B. Garriott in the *National Geographic Magazine*, from which the accompanying diagram of the storm has been reproduced. During August 7 and 8 the character and extent of the destruction caused in the Leeward Islands, Porto Rico, and Santo Domingo were such as will make the hurricane rank among the historical storms of the West Indies. At San Juan, in Porto Rico, the barometer began to fall at 10 p.m. on August 7, and the lowest recorded reading, 29·23 inches, was



The West Indian Hurricane.

reached at 8·30 a.m. on August 8. The hurricane was strongest at San Juan between 7 and 9 a.m. on August 8, when the wind velocity was calculated by a U.S. Weather Bureau observer at 85 to 90 miles an hour. The rainfall was very heavy, a total of 6·37 inches falling, of which 4·18 inches fell from noon to 8 p.m. on August 8. By prompt action the U.S. Weather Bureau were able to warn many places of the approach of the hurricane centre. Prof. Garriott states that the warnings outran the storm by a period which varied from a few hours at the easternmost Leeward Islands to thirty-six and forty-eight hours at points along the South Atlantic coast and gulf parts of the United States.

THE pilot chart of the North Atlantic ocean for November contains a very useful map of the hurricane tracks during the ten-year period, 1890–99, and the distance travelled by each storm centre during twenty-four hours. With a few exceptions the tracks exhibit the usual features, the motion of the centre in that portion of the track to the southward of latitude 25° being directed towards a point between north and west, and thence moving in a north-easterly direction. The position of this point of recurvature or point of greatest westing is arranged in a tabular form. From this table it is evident that to rely upon the assertion that the storms of a particular month in the West Indies recurve within certain fixed and narrow limits of latitude may lead to serious error at a most critical time. Thus the hurricanes of September, instead of recurving between 27° and 29°, as formerly maintained, may recurve in any latitude from 20° 20′ to 33° 30′ north. Likewise those of October, instead of recurving in latitude 20°—23° north, may continue their north-westerly course until the parallel of 39° is attained.

THE Deutsche Seewarte has published in a quarto volume the results of meteorological observations made on board German ships for the ten-degree square of the North Atlantic comprised between latitude 20°–30° N. and longitude 60°–70° W. This is the seventeenth square, for which the observations have been similarly discussed and published, in the district of the North Atlantic lying between latitude 20° and 50° N., leaving but a small area to complete this very valuable work. It joins on to the nine ten-degree squares lying between latitude 20° N. and 10° S. and longitude 10° to 40° W. discussed and published some time ago by the Meteorological Council, so that shipmasters navigating that part of the ocean have at their disposal a large amount of trustworthy information extending over a considerable number of years. The observations are given in a tabular form for each month, and for each one-degree square, and the results are then combined for each five-degree square. They show the distribution of winds under 16 points of the compass, the prevalence of storms, the mean barometric pressure, air and sea temperature, duration of rainfall and other useful data, and the form adopted allows of the results of future years, or of those obtained by other countries, being added; so that, if desired, comprehensive charts, from accumulated materials, could be constructed without going through the preparatory work *de novo*.

TWO or three months ago reports were published in the daily press of the discovery of an electrical method of giving sight to the blind. It was alleged that Mr. Stiens had succeeded in constructing an electrical apparatus which performed all the functions of the eye and was an efficient substitute for it. Like many other newspaper reports of so-called scientific discoveries, this has proved to be without sound foundation. Mr. G. H. Robertson, who is himself afflicted with blindness, describes in the *Electrician* the results of personal inquiries into the matter with a member of the staff of our contemporary. In spite of several visits to Mr. Stiens, no experimental proof in substantiation of the claims which were put forward on his behalf was obtained, and the conclusion arrived at is that these claims are foundless. Life is so short and crowded with so many important duties that it is impossible to investigate the many sensational statements made by irresponsible interviewers, but we are grateful to any one who will take the trouble to examine some of the rumours which are put forward in the name of science.

IN the *Bulletin* of the French Physical Society, No. 137, is described an ingenious disposition for estimating the duration of Kerr's phenomenon, in which certain dielectric liquids are made to assume the optical properties of double refracting crystals by placing them between the plates of a condenser. The light observed is produced by the spark by which the condenser is discharged, and the time interval between the discharge and the passage of the light through the condenser may be varied by an arrangement of mirrors, whereby the rays may be made to traverse any length of path required. The experimenters, MM. Abraham and Lemoine, find from these investigations that Kerr's phenomenon is reduced to half its original value in the four-hundred-millionth of a second, and becomes insensible in the one-hundred-millionth of a second after the discharge of the condenser. MM. Abraham and Lemoine have also succeeded in showing Kerr's phenomenon for a conducting liquid. The Kerr's condenser, having water between its two armatures, is arranged in the circuit connecting two ordinary condensers in series. On discharging these by the spark used as the source of light the charges liberated instantaneously charge the plates of the Kerr's condenser. For a very small interval of time the water is affected in the same way as a dielectric, and on observing the analyser a brilliant reappearance of light establishes the existence of the phenomenon.

IN the *Bulletin International* of the Cracow Academy, M. P. Rudski continues his papers on the elastic properties of rocks. It would appear that even such rocks as granite cannot be regarded even "grosso modo" as isotropic; but the expression for the elastic potential generally involves five constants. There are no grounds for assuming the separate propagation of dilatational and torsional waves in gneiss, granite and similar rocks; on the contrary, the actual waves are partly torsional and partly dilatational.

THE *Mineralogical Magazine*, vol. xii., No. 56, which has just appeared, contains a description of a new three-circle goniometer designed by Mr. G. F. H. Smith, and intended for comparatively rapid measurements of the geometrical constants of crystals and the indices of their faces. The paper gives a historical account of the one-circle goniometer of Wollaston, the two-circle or "theodolite" goniometer of Miller, and then describes the new instrument, which is a combination of those forms. The great advantage of the combination is that the crystal is adjusted once for all. The measurements may be made in any desired zone, the orientation of which is at once determined. For crystals small enough to be firmly held by wax in all positions, the most convenient arrangement is to give all three motions to the crystal; but, if necessary, the telescope and collimator may have one or more.

THREE noteworthy papers on the cultivation and manufacture of tobacco have recently appeared. One of these publications is Report No. 60 of the U.S. Department of Agriculture, and in it Mr. Milton Whitney and Mr. T. H. Means describe their investigations upon the temperature changes in fermenting tobacco in Florida and Connecticut. The report also comprises a *résumé* of Dr. Oscar Loew's investigations of the cause of fermentation, which throw light upon and explain the observed temperature changes, and the necessity of maintaining a definite amount of moisture in the tobacco during the curing and fermentation. In another paper (Report No. 62), published by the U.S. Department of Agriculture, Mr. Marcus Floyd describes the cultivation of cigar-leaf tobacco in Florida, where striking developments of the tobacco industry have taken place in recent years. The object of collecting information of this kind is to investigate whether the crops produced on the various types of tobacco soils are the best obtainable with the present state of knowledge and skill in manipulation. In this way the Department of Agriculture is making a scientific study of the possibilities of the improvement and extension of an important industry. The third paper mentioned, on the cultivation and manufacture of tobacco, appears in the *Revue Générale des Sciences* for October 30, and is accompanied by a map showing the districts in which tobacco is cultivated in France.

"THE Geology of the Country around Dorchester" is the title of a Memoir (price 1*s.*) just issued by the Geological Survey in explanation of the new series map, No. 328. The Memoir is written by Mr. Clement Reid, and it deals mainly with the chalk, eocene strata and drift. Among the more interesting natural features in the region are the numerous swallow-holes on Puddletown Heath and adjacent tracts. Perhaps the largest is that known as Cull-pepper's Dish, a hollow about one hundred yards long and forty feet deep. Another is known as Hell Pit. Altogether there are some six hundred of these pits, due to the dissolution of the chalk and the subsidence of superincumbent tertiary deposits. Mr. Reid points out that the lower tertiary (Reading) beds consist locally of sands with impersistent beds of clay. The rainfall readily sinks into the porous ground until arrested by one of the clay-bands, and these guide the water in particular directions, whence it descends and dissolves the chalk. The Reading beds and London clay vary considerably from their equivalents elsewhere, the London clay consisting largely of sand and sandy loam. The Bagshot beds furnish evidence of true river-deposits which replace the more estuarine strata of the eastern part of the Hampshire basin. Large pits near Moreton station show (beneath plateau gravel) Bagshot beds comprising current-bedded sand, pipe-clay and gravelly seams containing chalk-flint, Greensand chert, Purbeck limestone, Radiolarian chert, and Schorl-rock. Here, in fact, are found fragments of all the rocks which occur further west in gravels which have been regarded as drift, but which Mr. Reid considers, with good reason, to be of Bagshot age. The accounts which he gives of these and other deposits will be read with interest. Among the latter we may mention the Pliocene formation at Dewlish, the clay-with-flints, plateau gravels, and more recent deposits.

SOME interesting experiments on the rate of multiplication of various yeast cells have been carried out by Dr. D. P. Hoyer, of Vienna, and are published in the *Centralblatt für Bakteriologie*, Part ii., No. 21. The author has determined the time required at different temperatures, 13° C. and 20° C. and 25° C. respectively, by various yeasts to produce a new generation from a parent cell. Thus at 13° C., *S. ellipsoideus I. Hansen* requires nine hours and four minutes, and at 25° C. six hours and twelve minutes; *S. membranae-faciens* at 13° C. seven hours and one minute, and at 25° C. five hours and thirteen minutes to form a new generation. At 6° C. it appears that the majority of the yeasts investigated did not, even after a week, produce a new generation, and the experiments conducted at this temperature were discontinued. The yeasts thus so closely scrutinised were grown on gelatine, and were not more than from three to four days old. Many bacteria have been submitted to similar observations; but until these experiments, made by Dr. Hoyer, were published, scarcely any investigations of this kind, in regard to yeasts, have been recorded.

THE *Bulletin of Miscellaneous Information* (Trinidad) for October contains a fuller diagnosis of the new fungus-parasite of the cacao-plant, *Nectria Bainii*, Mass. It seems, however, still doubtful whether it is the cause of the disease, or simply saprophytic.

IN the number of the *Agricultural Gazette of New South Wales* for October is a very interesting further account, by Mr. J. H. Maiden, of a botanical visit to Mount Kosciusco. The flora presents some Alpine features, but the flowers are not specially large or brilliant. There is an extraordinary predominance of white flowers, almost exactly one-half of those gathered at high altitudes. The flora presents, on the whole, a strong affinity with that of Tasmania. A list of the plants collected is appended.

THE *Journal of the Royal Horticultural Society* for November, besides purely horticultural papers, contains several *résumés* of the present state of our knowledge in various branches of botany:—On the dispersion of seeds, by Prof. Boulger; and on the importance of light and heat to plants; on movements of plant organs; and on fertilisation by insect agency, by the Rev. G. Henslow, read at the meetings of the Society. In the last of these papers, Mr. Henslow sums up strongly against Darwin's dictum that "Nature abhors perpetual self-fertilisation," which, however, he quotes as "Nature abhors self-fertilisation," an assertion never made by Darwin.

THE second volume of Dr. Isaac Roberts' "Photographs of Stars, Star Clusters and Nebulæ" is about to be issued from the publishing office of *Knowledge*. It will contain seventy-two photographs reproduced by the collotype process, in addition to many pages of text. Only a limited number of copies of the work will be available for the public.

A SECOND fully revised edition of "The Physiology of Plants: a Treatise upon the Metabolism and Sources of Energy in Plants," by Dr. W. Pfeffer, professor of botany in the University of Leipzig, translated and edited by Dr. Alfred J. Eward, will be issued immediately from the Clarendon Press.

THE members of the St. Marylebone Natural Science Society apparently derive a large amount of pleasure and instruction from one another, for the report on the meetings held during the present year shows that a number of interesting papers on diverse subjects were read before the Society. Every organisation which creates and fosters a love of natural knowledge furthers the interests of science; therefore, we are glad to know of the activity of the scientific society of St. Marylebone.

THE only ionising inorganic solvents hitherto found in addition to water are nitric acid and liquefied ammonia. In the current number of the *Berichte* Prof. Walden, of Riga, gives a preliminary account of experiments with liquid sulphur dioxide, which shows that this liquid acts to an unsuspected degree as a solvent for inorganic and organic substances. Since it permits of double decompositions, and gives electrolysable solutions, liquid sulphur dioxide must now be reckoned as an ionising solvent. Many substances dissolve in liquid sulphur dioxide with characteristic colours. Thus the iodides of the alkalis and alkylammoniums dissolve with a yellow colour. As an example of double decomposition, the action of potassium iodide on trimethylammonium chloride may be cited. These substances in sulphur dioxide solution give a precipitate of potassium chloride. Ferric chloride and ammonium sulphocyanide give the usual red colour of ferric sulphocyanide. The electrical conductivity of salts in sulphur dioxide solution is not the same in order as that in aqueous solution, nor does the molecular elevation of the boiling point in liquid sulphur dioxide correspond altogether with that found in aqueous solutions. Prof. Walden promises a thorough investigation of the many points of interest raised by this new discovery.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*, ♂) from South Africa, presented by Mrs. A. Rousbey; a Persian Gazelle (*Gazella subgutturosa*, ♂), a Chaplain Crow (*Corvus capellanus*) from Persia, presented by Mr. B. T. Ffinch; two Chipping Squirrels (*Tamias striatus*) from North America, presented by Mr. C. M. Stewart; two Snake Fishes (*Polypterus senegalus*) from the River Gambia, presented by Mr. J. S. Budgett; an Indian Antelope (*Antilope cervicapra*, ♂), a Banded Parrakeet (*Paloeornis fasciatus*) from India, a Sooty Phalanger (*Trichosurus fuliginosus*, ♂) from Tasmania, a Fennec Fox (*Canis cerdo*) from North Africa, deposited; two Red-backed Buntings (*Emberiza rutila*) from Japan, purchased.

OUR ASTRONOMICAL COLUMN.

HOLMES' COMET (1899 *d*).

Ephemeris for 12*h*. *Greenwich Mean Time.*

1899.		R.A. h. m. s.		Decl. ° ′ ″
Nov. 30	...	2 8 58·72	...	+46 44 50·0
Dec. 1	...	8 24·88	...	36 25·1
2	...	7 53·24	...	27 54·2
3	...	7 23·83	...	19 18·2
4	...	6 56·65	...	10 37·7
5	...	6 31·72	...	46 1 53·4
6	...	6 9·05	...	45 53 5·9
7	...	2 5 48·62	...	+45 44 16·0

COMET GIACOBINI (1899 *e*).

Ephemeris for 12*h*. *Berlin Mean Time.*

1899.		R.A. h. m. s.		Decl. ° ′
Nov. 30	...	18 4 13	...	+12 13·7
Dec. 1	...	5 55	...	12 30·5
2	...	7 36	...	12 47·4
3	..	9 18	...	13 4·4
4	...	11 0	...	13 21 4
5	...	12 42	...	13 38·5
6	...	14 24	...	13 55·7
7	...	18 16 7	...	+14 13·0

SPECTROSCOPIC BINARIES.—(1) α *Aurigæ* (*Capella*). Prof. W. W. Campbell, from examination of six spectrum plates of the star obtained with the Mill's spectrograph during 1896–97, finds decisive evidence of its being a spectroscopic binary. The component having a spectrum of the solar type showed velocities of 34, 54, 49 and 3 kilometres per second from 1896, August 31, to 1897, February 4. The spectrum of the second component appears to consist chiefly of Hγ and the more prominent iron lines (*Astro. Physical Journal*, vol. x., p. 177). (2) α *Ursae Minoris* (*Polaris*). Photographs of the spectrum obtained in 1896 showed no decided evidence of variable velocity. Others taken in August 1899 gave such different values, ranging from −15·2 to −9·0 kilometres per second, that the star was suspected to be a short period variable, and a curve was plotted from additional observations specially made. (*Astro. Physical Journal*, x., p. 180). The 1896 values of the velocity lie altogether out of the recent measures, and this is the reason assigned for suspecting the presence of a disturbing force in the form of a third component. The period of the chief pair is about 3d. 23h. All the observations were made with the Mill's spectrograph on the 36-inch refractor.

In the same number of the *Journal*, p. 184, Prof. E. B. Frost, of the Yerkes Observatory, gives the velocities in the line of sight of this star, obtained from spectrograms taken with the 40-inch refractor. The resulting values quite confirm the short period variation found by Prof. Campbell, and the range in velocity (7 kilometres) is also closely in agreement.

POSITION OF PERTH OBSERVATORY.—Mr. W. E. Cooke, Government Astronomer at the Perth Observatory, Western Australia, has recently, with the co-operation of Sir Charles Todd, of the Adelaide Observatory, determined the latitude and longitude of the station. The latitude was determined by observations of meridian zenith distances of circumpolars, and the final adopted value is

Latitude 31° 57′ 09″·63 S.

The longitude was found by interchanges of clock signals between Perth and Adelaide, the adopted value being

Longitude = 7h. 43m. 21·74s. E.

VARIATIONS IN THE SPECTRUM OF ORION NEBULA.—Prof. Scheiner, in the *Astronomische Nachrichten*, Bd. 150, No. 3593, made some lengthy criticisms of Prof. Keeler's observations of the spectrum of the Orion Nebula, obtained with the Lick telescope. Prof. Keeler's reply is given in No. 3601, and the *Astro. Physical Journal*, vol. x., pp. 164–8, contains both the reply and a translation of Prof. Scheiner's article. The experiment consisted in obtaining two photographs of the nebula, one on an ordinary plate, the other on an isochromatic plate protected by a greenish-yellow screen. The resulting negatives showed considerable differences in the relative intensities of several parts of the nebula. Prof. Scheiner pointed out the doubtful comparison of different types of plates, the possible photographic exaggeration of really minute differences of intensity, and the difficulty of observations of such faint phenomena.

To this Prof. Keeler replies, "That the difference between the plates is not sufficient to explain the irregularities found, as the *star* images on both plates are equally intense; the differences in intensity are measured from point to point on the *same* negative, not from one to the other; the observations are neither difficult or delicate, as the light given by the 36-inch is quite sufficient for the purpose.

A NEW ROCKING MICROTOME.

SERIAL section-cutting has sprung into such prominence during the last fifteen years, and has now become so essential to almost every branch of biological research, that we are apt to forget that we are still using, practically unmodified, one of the earliest invented automatic microtomes. The Rocking Microtome designed by the Cambridge Scientific Instrument Company was first put before the public in 1885, within a short time of the appearance of the very earliest of all automatic microtomes, that designed by Caldwell and Threfall. The simplicity, efficiency and cheapness of the former soon caused it to become both widely known and used by all biologists, and it may be doubted whether any instrument has ever spread so rapidly and deservedly over so wide an area as the familiar "rocker" which is now a characteristic feature in all laboratories in which any branch of biology is taught.

Considering the number of years which the microtome has been in use, and the variety of purposes which it has been made to serve, it is not surprising that several small alterations have been made in it from time to time; none of these, however, have affected the essential features of the rocker, which remains the same instrument to-day that it was years ago.

Recently the Cambridge Instrument Company brought out an enlarged and improved form to obviate what has generally been regarded as the chief defect of the "rocker," viz., the fact that, owing to the principle upon which this instrument is constructed, the cutting surface was of a necessity a curved one. This microtome, however, is too expensive to replace the rocker for which, in spite of its curved cutting surface (a defect of no moment in most work), there was and is still a great demand. The makers have, therefore, set to work to remedy certain minor defects in the rocker, and have, as a result, placed what they consider to be a greatly improved microtome on the market.

The new microtome, as will be seen from the figure, is of much the same form as the old design, and is built upon the same principle, the chief difference being in the bearings of its working parts, and in the addition of one or two new features.

The following advantages are claimed for the new model:—

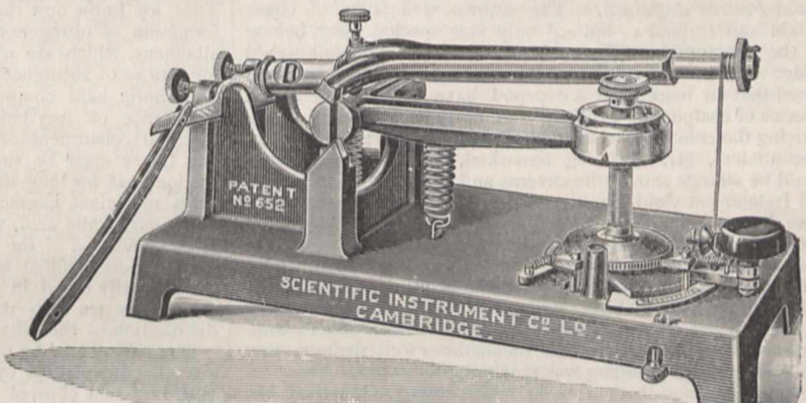
(1) Increased rigidity.
(2) Impossibility of tearing sections on the upward movement of the object.
(3) Impossibility of cutting thick and thin sections.
(4) Graduated arc for showing the thickness of the sections.
(5) Catch for holding object above the razor edge.
(6) Improved method of fixing the cord.
(7) New object-holder.

Most of these are small but useful additions to the microtome, which by themselves would call for no special comment. The chief features presented by this instrument, and through which it claims more than passing notice, are Nos. 2 and 3 in the above list.

Every one who has had much experience in serial section-cutting will at one time or another, no matter what automatic microtome he was using, have found that the sections were torn or lifted off the edge of the razor, and adhered to the block of paraffin on the upward stroke. It is to obviate this trouble that the modified rocker has appeared.

All possibility of this injury to the section is prevented in this model by the fact that in the upward movement the object cannot touch the razor, since, by means of an additional pawl which at the end of the stroke turns the screw down by four teeth on the notched wheel, the object is drawn backward before the upward movement commences.

This apparatus acts perfectly, but may possibly introduce a new source of damage to the machine, viz., additional wear to the notches on the toothed brass wheel. As one who has used a rocker since its first appearance, I can state that the only serious trouble I ever had with this instrument was due to the wearing down of these teeth; therefore, it seems to me that the addition of a second steel pawl will cause these important structures to wear away more quickly. After all, is the occasional displacement of the section in the upward movement due to a defect in the older microtomes? Or is it not rather due to carelessness on the part of the manipulator, a blunt razor, a paraffin block with imperfectly trimmed edges, and the latter not arranged parallel to the edge of the razor? Personally, I believe the operator is generally to blame, and that it is due to a combination of the above mistakes on his part. But even if it is so, we ought to thank the makers for trying to save us from ourselves, and if the extra pawl will not wear the very important teeth too much, it should prove a very useful addition to the microtome, since even the most careful of us are apt to err at times, and it is very trying to struggle with an object which will not ribbon.



Most of the bearings of the machine are based on a new design, which is said to reduce wear and friction. That at the base of the big screw, as now spherical instead of conical, this is believed to prevent the cutting of thick and thin sections. How far this is a fact time only can tell, but a trial of the instrument with very hard and trying objects gave highly satisfactory results.

The whole instrument is much more rigid than the old form, and the addition of a catch for holding the object above the razor, the improved cord fixer, the graduated scale for showing the thickness of the sections, and the new compact object-holder provided with universal movement, will add much to the utility of the machine. It is to be hoped, however, that the scale will be quite accurate; the divisions on the scale attached to the machine (a rough model only), which has been examined, did not appear quite equal, some giving two and some three teeth.

It may be mentioned that the new microtome will be issued at practically the same price as the old form, and should, with its new additions, prove a boon to all biologists. M. F. W.

CORRESPONDING SOCIETIES OF THE BRITISH ASSOCIATION.

THE meetings of the Conference of Delegates of the Corresponding Societies were held in the Mayor's parlour at the Town Hall, Dover, on September 14 and September 19.

First Meeting.—The Corresponding Societies Committee of the British Association were represented by Rev. T. R. R.

Stebbing (Chairman), Rev. J. O. Bevan, Mr. G. J. Symons, Prof. W. W. Watts, and Mr. T. V. Holmes (Secretary).

A short report, stating that the resolution passed at the Bristol meeting of the conference of delegates on the desirability of securing the co-operation of the coastguard as observers of coast erosion had been favourably received by the Admiralty, and giving copies of the forms issued to the coastguard for the promotion of uniformity in their observations was in the hands of every delegate present, and was taken as read. Then Rev. T. R. R. Stebbing, after alluding to the result of last year's discussion on coast erosion, read a short paper on the living subterranean fauna of Great Britain and Ireland.

The first undoubted mention of an underground crustacean seemed to be that of an amphipod found in London and named by Dr. Leach, of the British Museum, in 1813. Since that time many valuable treatises on the subterranean fauna of various parts of the globe have appeared in many European languages, Polish among others. The English student might be advised to study "The Cave Fauna of North America," by Dr. Packard, published in the *Memoirs* of the National Academy of Sciences, vol. iv., Washington, 1888. Also "The Subterranean Crustacea of New Zealand," by Dr. Charles Chilton, published in the *Transactions* of the Linnean Society of London, 1894. Packard enumerated 308 European cave animals and 102 American. This list of 410 included a few Protozoa, a sponge, two hydras, a few worms, one mollusc, several crustacea and myriapods, numerous arachnids and a host of Coleoptera, the other insects being chiefly Thysanura. The vertebrates consisted of four American fish and one European batrachian, the celebrated *Proteus anguineus*. The known well fauna of Great Britain and Ireland comprised only four species which belong to the amphipoda. These, however, de Rougemont would reduce to a single species. In addition, it may be mentioned that an insect and a copepod have been found in the recesses of coalpits in Scotland and northern England. After noticing the colourlessness and blindness characteristic of subterranean fauna, Mr. Stebbing remarked, in conclusion, that it would be strange should the caverns and wells of Great Britain and Ireland not yield, on investigation, a fauna comparable in some degree to that found in other parts of the world. In this research he hoped that some members of our local scientific societies might take a share.

In answer to a question as to the best way of catching the well shrimp, Mr. Stebbing replied that a good plan was to wait till the well was nearly empty, then let down a bucket and withdraw it as quickly as possible. Sometimes well shrimps were brought up when pumping was going on.

Some discussion then arose, in which Rev. J. O. Bevan, Mr. T. Workman, Mr. Hotblack and Mr. Stebbing took part, as to whether the bats in the Mammoth Cave at Kentucky passed all their time there. The matter could not be absolutely settled, though there seemed to be a presumption against their doing so; Mr. Workman stating that he had not found them in the depths of the cave, though they were in large numbers near the mouth.

SECOND MEETING OF THE CONFERENCE, SEPTEMBER 19.

The Corresponding Societies Committee were represented by Rev. T. R. R. Stebbing (Chairman), Dr. Garson, Mr. G. J. Symons, Prof. W. W. Watts, and Mr. T. V. Holmes (Secretary).

After a long and desultory debate on the best ways of increasing the usefulness of the meetings of the Conference, during which Mr. Stebbing was obliged to leave, and Prof. W. W. Watts became Chairman, Mr. Hugh Blakiston, Secretary of the "National Trust for Places of Historic Interest or Natural Beauty," delivered an address on the aims and work of the Trust.

Section A.—Mr. G. J. Symons stated that the Committee for Seismological Observations was much in need of a home.

Section C.—The Chairman remarked that the Erratic Boulders Committee had presented a report. The Geological Photographs Committee would be glad to receive contributions of photographs. They hoped shortly to be able to publish a selection of typical photographs. Their duplicate collection of prints and slides would be sent to any local society wishing to exhibit them.

Section D.—Rev. T. R. R. Stebbing said that the Secretary of Section D recommended the study of the fauna of wells and caverns to the Corresponding Societies.

Section K.—Mr. H. Wager had to inform the delegates that the Section had appointed a committee to consider the geographical distribution of mosses.

PROGRESS OF AGRICULTURAL CHEMISTRY.[1]

AN important address has been recently delivered by Prof. Maercker, of Halle, to the German Chemical Society (*Ber.* 1897, p. 464), summarising the advances which have been made in agricultural chemistry during the last twenty-five years. Prof. Maercker pointed out that the term Agricultural Chemistry meant more at the present time than the mere application of chemistry to agriculture, as shown by the fact that the agricultural chemist, in his efforts to assist the farmer, was often more concerned with the biological sciences than with chemistry; while, in addition to his purely scientific work, he was required to take account of economic questions of the day possessing special interest to agriculturists. The following account of the most important parts of the address is given under the following heads:—I. Plant-food; II. Soils and Manures; III. Artificial Selection. It is reproduced here by the kind permission of the editor of the *Imperial Institute Journal.*

I. PLANT-FOOD.

In supplying nourishment to plants we must know what substances are necessary, and in what form and quantity they should be provided. Little progress was made in our knowledge of the subject till the quite recent introduction of the method of water-cultures of Sachs, Knoop, and Nobbe and the method of sand-cultures of Hellriegel permitted of the conduct of experiments in pure media, and thus rendered it possible to ascertain not only what substances are essential for plant-life, but also the part played by each substance in the plant cell. Thus we know now that phosphoric acid is essential for the formation of nitrogenous substances in the plant, because the albumens, which are of fundamental importance in the transformations of substances in plants, result from an intermediate phosphoric acid compound, as is indicated by the regular occurrence of lecythin in protoplasm. Again, iron is an essential constituent of chlorophyll and sulphur of albumen, and hence must be supplied to plants. The true function of calcium was for long doubtful; its action is now known to be of a medicinal character, since it serves to neutralise the poisonous oxalic acid, which is always an intermediate product of the oxidation of the carbohydrates. It was formerly thought that calcium fulfilled some important function in the leaves, being chiefly found in the foliage of plants. Since, however, the leaves are also the chief seat of the oxalic acid, this distribution of the calcium is easily explained.

The part played by potassium has only within the last three years been explained by Hellriegel, who, by exact experiments with beet-root showed that the amount of sugar in the beet stands in close relation to the amount of potassium provided for the plant. P. Wagner has made the interesting observation that the potassium may be *partly* replaced by sodium.

The exact value of magnesium to plants is not yet well understood, but it appears to be of importance in the formation of the nitrogenous substances of seeds, as in these considerable quantities of magnesium phosphate occur.

Nitrogen is an indispensable plant-food, for it is an essential constituent of albumen.

In addition to the quantities of mineral substances required by plants to enable them to exhibit a healthy growth, further quantities are found to be essential to satisfy what has been termed, though not very aptly, the "*mineral-hunger*" of the plant. This is best explained by an example. E. Wolff found that for the production of 100 parts of oat-plant (dried), ·5 parts of phosphoric acid were necessary, when the remaining mineral substances were supplied in excess to the plant. By other similar experiments he showed that the following quantities of mineral substances were necessary for the production of 100 parts of oat-plant:—

Phosphoric acid	·50 parts
Potash	·80 ,,
Lime	·25 ,,
Magnesia	·20 ,,
Sulphuric acid	·20 ,,
	1·95 parts.

A total of 1·95 parts of mineral substances is therefore *necessary* in the case of the oat-plant. However, there is no oat-plant in nature which contains so little as 1·95 per cent.

[1] Reprinted from the *Kew Bulletin* (No. 144).

The minimum is 3 per cent. The difference, 1·05 per cent., is the measure of the "mineral-hunger" of the plant, and represents the mineral substance which does not perform any special function. This excess of mineral substance may be supplied in the form of some indifferent substance, such as silica. The observation is of considerable interest to the farmer, for it shows that it is not economical to manure crops with pure substances.

II. SOILS AND MANURES.

Having ascertained in general what substances are necessary as plant-food, the agricultural chemist has next to apply this general information to the manuring of soils which are more or less deficient in certain ingredients. It has been found, unfortunately, that the chemical analysis of a soil is of little use as a guide unless accompanied by what may be termed a "mechanical analysis," by which is meant chiefly a determination of the amount of finely-divided constituents present in the soil. It is only the finely-divided earth which presents a sufficiently large surface for the exercise of the solvent action of the water and its dissolved carbonic acid. There is one case, however, in which chemical analysis alone is of the greatest importance, viz. when only traces of some necessary element are present in a soil. Here there is no question of the need for a manure containing this substance.

If, on the other hand, large quantities of an element are present, it does not follow that there is a sufficiency in the soil even when the latter is in a satisfactory state of division, for the substance in question may be present in an insoluble or refractory form. This is commonly the case with nitrogen, which exists in the soil chiefly in the form of a mixture of indefinite nitrogenous substances known as *humus*, or mould. These substances sometimes easily give up their nitrogen to plants, but in other cases are very refractory. The uncertainty as to their action is indeed so great that certain peaty soils are known which consist almost entirely of humus, but contain, nevertheless, an insufficiency of available nitrogen.

Phosphoric acid affords another illustration. The soluble phosphoric acid of the manure is absorbed by the soil as dicalcic phosphate, which is comparatively easily soluble in the soil-water. With time, however, it may change in the soil to the insoluble tricalcium phosphate, or even to iron or aluminium phosphates, which are still less soluble.

In the case of calcium, chemical analysis has been found to be of considerable service in determining what manuring is required, since calcium is chiefly valuable in the form of carbonate or humate, and these are easily estimated in the soil.

Since then the direct method of soil-analysis is an insufficient guide to manuring, it is fortunate that chemists have been able to develop successfully an indirect method. This is the *cultivation method*, by which plants are allowed to grow in the soil under examination, after taking care to provide a sufficiency of all plant-food stuffs except the one, *e.g.* phosphoric acid, whose presence in available form is being tested. The plants are then analysed, and the results compared with the analyses of the same plants grown on soils provided with all the necessary plant-food stuffs. As an important result of the method it has been found that different plants take up very different quantities of the same mineral substances. On this is largely based the system of rotation of crops, where the second crop is so chosen that it chiefly removes the ingredients of the soil which have been left by the preceding crop.

With the aid of the cultivation method it has also been possible to draw up the following table, which represents the relative values of the different nitrogen compounds for plant-food.

Nitrogen of Saltpetre	100
,, ,, Ammonia	85–90
,, ,, Albumen	60

This table may be made use of in determining the nitrogen value of a manure.

The cultivation method may be used for testing the value of manures of all kinds. Thus it was by a few cultivation experiments that Wagner in Darmstadt first showed the very great value for agricultural purposes of the "Thomas" Slag, produced as a bye-product in the manufacture of iron by the basic process of Thomas Gilchrist. The million tons of phosphate meal annually produced in Germany is now wholly utilised by the agriculturist, and its preparation for the farmer has become an important offshoot of the iron industry.

Similarly the demonstration by the cultivation method of the value of potash salts in manures has given an enormous impetus to the potash industry.

Speaking generally, the method gives us complete control over the fertility of a soil in so far as this depends on manuring. One consequence of this has been that our views as to the value of agricultural land have completely changed, for whereas formerly sandy soils were generally considered poor, they are now, by means of a system of intelligently directed manuring, made to give yields which are scarcely inferior to those of the best soils. The beet-sugar industry, which formerly could only be conducted in the best soils, has now been extended with marked success to sandy soils.

III. ARTIFICIAL SELECTION.

It might seem that with a perfect knowledge of the manuring of plants, the need for further investigation would cease, for when we have learned exactly what each plant requires to attain its highest development, we have reached a certain limit. The supply of excessive nourishment is a disadvantage, and only tends to produce sick plants.

There still remains, however, a method by which the fertility of plants may be increased far beyond the limit which nature appears to have fixed. This is the method of artificial selection which has been applied in Germany on the most approved scientific principles. German agriculture would have long since broken down under the stress of foreign competition had it not been for the perfect technology of its agriculturists. As an example the sugar-beet may be quoted. This plant contained originally but a small amount of sugar, and could only be used as a source of sugar when the price of the latter was very high. With the fall in price came the urgent need for increasing the percentage of sugar in the beet-root. This was effected by utilising the fact that sugar-richness is hereditary, so that by selecting artificially the roots richest in sugar, getting seed from these, planting the seed, again selecting the richest roots, and so on, a race of plants is at length obtained in which a high percentage of sugar is normal.[1] Accordingly the producers of beet-root seed in Germany have erected great laboratories in which the percentage of sugar in the roots is carefully determined. By applying the principle of artificial selection with regard also to the form and size of leaf and the purity of the sap, it has been found possible to improve the roots from year to year, so that now beet-sugar can easily hold its own against cane-sugar, and is indeed cheaper than flour, costing as it does in Germany less than a penny a pound.

Similar success has attended the efforts to increase the crops of different kinds of grain. The improvement in malt-barley has been specially marked.

It has been found that plants which have been highly cultivated by artificial selection easily lose their acquired characters when they are exposed to unfavourable conditions of cultivation; and this has led to many exact investigations, conducted for the most part in Germany, during the last ten years, on the chemistry of plants. The most interesting of these trace the chemical history of nitrogen as it passes from the atmosphere to the soil, then into the substance of plants, and finally back into the atmosphere.

The corresponding cycle for carbon has long been known.

Most plants assimilate nitrogen only in the form of compounds. As, however, the total quantity of nitrogen compounds in the atmosphere is comparatively small, there must be some other source of nitrogen for plants. Now the classical researches of Hellriegel have shown that there is one class of plants, the *Leguminosae*, or nitrogen collectors, which are able to assimilate elementary nitrogen and so to leave a soil in which they have been grown richer in nitrogen compounds. It has been found that the power of acting as nitrogen collectors is always associated with the presence of micro-organisms on the roots, and that the assimilation of the nitrogen is in some way not understood due to the micro-organisms. The recognition of the power of leguminous plants to act as nitrogen collectors is manifestly of great practical importance, for it shows clearly that the best rotation of crops is one in which a leguminous crop is followed by one of nitrogen consumers, *i.e.* plants which cannot assimilate nitrogen directly.

[1] See *Kew Bulletin*, 1897, pp. 317, 318.

Leguminous plants, whether first used as fodder for animals or simply left to decay in the soil, have their albumen changed in the first instance to amides, which under the influence of ammonia-ferments are decomposed with formation of ammonium-carbonate. The saltpetre bacillus then converts the ammonium-carbonate (and probably also amides) into saltpetre, *i.e.* into the best form of nitrogen plant-food.

Unfortunately the whole of the nitrate thus formed is never available for plants, on account of the destructive action of the nitrate-destroying bacilli, which decompose the nitrates with evolution of free nitrogen, and so complete the nitrogen cycle.

The nitrate destroyers are usually present in stable-manure, and cause a deplorable loss to agriculture, amounting in Germany to a sum of several million pounds annually.

Efforts which, as Prof. Maercker assured the German Chemical Society, are likely to meet with success at an early date, are being made to avoid this loss; and for this purpose special bacteriological investigations are now being conducted at many agricultural stations in Germany.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Langley, F.R.S., has been appointed Chairman of the Examiners for the Natural Sciences Tripos.

Mr. E. A. N. Arber, of Trinity, has been appointed Demonstrator in Palæobotany.

Mr. W. F. Cooper, of Clare, has been nominated to the occupation of the University table in the Naples Zoological Station.

Mr. H. H. W. Pearson, of Gonville and Caius, and Mr. J. Barcroft, Fellow of King's, have been awarded the Walsingham medals for research in botany and in physiology, respectively.

The degree of Master of Surgery was on November 23 conferred on Mr. Timothy Holmes for his distinguished contributions to the art and science of surgery.

Sir Ernest Clarke has been re-appointed Gilbey Lecturer in Agricultural History and Economics for the ensuing year.

Prof. Woodhead, and Drs. Anningson, Collingridge, Notter, and Stevenson, have been appointed Examiners in State Medicine.

Dr. Somerville, Professor of Agriculture, has been elected a Fellow of King's College.

THE Lawrence Scientific School of Harvard University has received a gift of twenty thousand dollars to be used to equip the mining and metallurgical laboratories.

DR. PAUL STAECKEL, assistant professor of mathematics at Kiel, has been appointed professor ordinarius. Dr. J. Traube, privatdocent in physical chemistry at the Berlin Technical High School, has been appointed professor.

THE new leather industries buildings in connection with the Yorkshire College, Leeds, which have been erected by the Skinners' Company of London at a cost of 5000*l.*, were opened on Monday by the Master of the Guild, Mr. J. Colman. In addition to the gift of the buildings the Company has granted an endowment of 250*l.* a year for ten years, thus placing the instruction in the branches connected with the leather industry on a solid foundation.

THE Canadian *Educational Review* announces that Sir W. C. McDonald, of Montreal, whose magnificent gifts to McGill University have made him justly celebrated as a public benefactor to education in Canada, has placed in the hands of Prof. Robertson, Dominion Agricultural Commissioner, sufficient funds to establish for three years technical schools in various centres throughout the Dominion. The nature of the plan is to take one city or town in each province in which to establish regular classes in some of the ordinary schools on one or two days a week, in which scholars between nine and thirteen years of age shall spend a portion of the day in actual work with tools. This will be supplemented whenever desired by more advanced and special evening classes in manual training and technical instruction.

A COPY of the *Magnet*, the magazine of University College, Bristol, has been received. There are several noteworthy articles and items of information in the magazine, not the least interesting being the editorial note on the appointment of Dr. Ryan, professor of engineering, to the principalship of the Woolwich Polytechnic. Dr. Ryan has been at the College for fourteen years, and has devoted his best energies to bringing the engineering department to its present satisfactory position. He would have done much more if the funds at his disposal had permitted him to develop the work of the department; but, unfortunately, the College possesses only a small endowment, and Bristol manufacturers are not so actively interested in the progress of their University College as are many commercial men in Liverpool, Birmingham, and other cities. Leaving this point, attention may be called to an article in the *Magnet* on life in a mediæval university, by Dr. Hastings Rashdall. The description of the ceremonies through which the freshman or bejannus of the middle ages had to pass before he could call himself a student of the university would suggest many comparisons to an ethnologist. It must be remarked that the periodical does not show the signs of active interest in scientific work which are given in the form of notes and articles in some other magazines of the same type.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 24.—Prof. G. Carey Foster, F.R.S., Vice-President, in the chair. —A paper on the conductivities of certain heterogeneous media for a steady flux having a potential was read by Dr. C. H. Lees. Two formulæ have already been proposed to express the conductivity of a mixture in terms of the conductivities of its constituents. In the first formula the conductivity is represented as the sum of a number of terms, each one of which is the product of the conductivity of any constituent and the fractional part of the mixture which is made up of that constituent. In the second formula the resistivity of a mixture is expressed in the same way with respect to the resistivities and percentages of its constituents. In general, the first of these suppositions gives results which are above the experimental values, while the second gives results which are below. If we suppose that the mixture is made up of a series of columns of the separate parts stretching normally between two equipotential surfaces, then the conductivity would be accurately represented by the first formula. If, however, we assume that the constituents are arranged in parallel layers, then the second formula would apply. In the present paper the author has attacked the problem two-dimensionally, and has investigated the relation which holds between the conductivities, when the constituents are arranged in the mixture alternately like the squares on a draughts board. Dealing first with two components it is easily shown that the problem reduces itself to finding the form of the equipotential curves and of the stream lines in a square which is divided by a diagonal into two parts of different material. By means of conformal representation Dr. Lees has referred the square under consideration to a kite-shaped quadrilateral with two opposite angles right angles, and the other two so determined by the conductivities of the constituents as to give straight equipotential lines in the two portions of the figure which represent the two materials and which are separated the one from the other by the axis of symmetry. The general relation which exists between the vector co-ordinates in the two systems has been proved by Love to consist of elliptic functions; but near the angular points of the figures a close approximation can be obtained by the use of a simple exponential expression. Taking the known solution to the problem in the case of the kite-shaped quadrilateral, it is easy to calculate the result for the square under consideration. This leads to the conclusion that the conductivity of the square is the geometric mean of the conductivities of the constituents. Allowing the medium to become fine-grained and introducing new materials, it follows at once that the logarithm of the conductivity of a mixture is equal to the sum of a number of terms, each one of which is the product of the logarithm of the conductivity of any constituent and the fractional part of the mixture which is made up of that constituent. By a superposition of fluxes, the author has shown that the above law holds for flows in four directions, and he therefore considers that with the assumed structure the formula represents the conductivity for any flux.—Dr. Lees then read a second paper on the thermal conductivities of mixtures and their constituents.

In this paper the three formulæ considered in the preceding communication are applied to the known experimental results upon the conductivities of mixtures of liquids. The author finds that the least satisfactory formula is the first one, whereas the least unsatisfactory is the logarithmic one. Mr. Appleyard said that it was frequently of importance to be able to determine the resistance of a mixture of gutta-perchas from the known resistances of component parts. He had attempted, without success, to do this by means of the old formulæ, and he would be interested to see whether Dr. Lees' logarithmic formula gave better results. In electrical work Mr. Appleyard pointed out that the nature of the contacts affected the conductivity, the resistance of a sheet of rubber being different when measured between metal plates and mercury sheets. Mr. Campbell said that the difference between the calculated and observed results might be due to the thermoelectric properties of the materials. Lord Rayleigh had observed that the high resistivity of alloys might be due to a back E.M.F. produced by the contact of dissimilar metals. Mr. Campbell said that he had measured the resistances of ferro-nickels both with direct and alternating currents, and found them the same in the two cases. In reply, Dr. Lees said that all his experimental work on conductivity had been carried out with mercury contacts.—The Society then adjourned until December 8, when, by the invitation of Prof. S. P. Thompson, the meeting will be held in the Physical Laboratory of the Finsbury Technical College.

Chemical Society, November 16.—Prof. Thorpe, President, in the chair.—The following papers were read.—The chlorine derivatives of pyridine. Part IV. The constitution of the tetrachloropyridines, by W. J. Sell and F. W. Dootson. The authors have determined the constitutions of the three known and theoretically possible tetrachloropyridines.—Contributions to our knowledge of the aconite alkaloids. Part XV. On japaconitine and the alkaloids of Japanese aconite, by W. R. Dunstan and H. M. Read. The authors show that Japanese aconite, *A. Fischeri* ("Kuza uzu"), contains japaconitine, $C_{21}H_{29}(OMe)_4(OCMe)(OCPh)NO_3$, which, contrary to the views of many investigators, is chemically distinct from aconitine.—The dissociation constants of very weak acids, by J. Walker and W. Cormack. Using a special form of apparatus, the authors have determined the electrical conductivity of solutions of feebly acid substances, such as phenol, hydrogen sulphide and acetic, carbonic, boric and hydrocyanic acids; the behaviour observed is in accordance with Ostwald's dilution law.—Preparation and properties of solid ammonium cyanate, by J. Walker and J. K. Wood. Pure solid ammonium cyanate may be obtained by mixing cooled ethereal solutions of ammonia and cyanic acid; its molecular heat of transformation into solid urea is 49 K, whilst in aqueous solution this constant is 75 K.—Etherification of derivatives of β-naphthol, by W. A. Davis.—On the determination of transition temperatures, by H. M. Dawson and P. Williams. The authors' method of determining transition temperatures depends upon ascertaining the point at which the two branches of the density or electrical conductivity curves at temperatures above and below the transition point, intersect each other.—Constitution of amarine, of its supposed dialkyl- and diacyl-derivatives and of isoamarine, by F. R. Japp and J. Moir. The authors regard amarine as a *cis*-diphenyl compound of the constitution

$$\begin{matrix} CHPh.NH \\ | \\ CHPh-N \end{matrix}\!\!\gg CPh,$$

Snape's isoamarine being the corresponding *trans*-isomeride; the latter is readily obtainable by fusing amarine with sodium or heating its hydrochloride above the melting point.—The atomic weight of nitrogen, by G. Dean. The ratio Ag : AgCN was found to be 107·93 : 133·962, whence CN = 26·032 and N = 14·031 if C = 12·001.

Mineralogical Society, November 14.—Prof. A. H. Church, F.R.S., President, in the chair.—Dr. E. Hussak and Mr. G. T. Prior gave an account of a new Brazilian mineral, Florencite, a hydrated phosphate of aluminium and cerium earths ($3Al_2O_3.Ce_2O_3.2P_2O_5.6H_2O$), crystallising in the rhombohedral system. The mineral is isomorphous with the recently discovered Hamlinite, to which it is also very similar in chemical composition; the strontium and barium of Hamlinite being replaced in Florencite by cerium earths.—Mr. A. Hutchinson described a new mineral, Stokesite, from Cornwall, of peculiar chemical composition. It is a hydrated silicate of tin and calcium, $CaO.SnO_2.3SiO_2.2H_2O$, and crystallises in the orthorhombic system in forms closely resembling gypsum, from which it is easily distinguished by its much greater hardness.—Mr. R. H. Solly contributed a paper on sulpharsenites of lead from the Binnenthal, and gave descriptions of the crystallographic characters of the rare minerals, Rathite and Jordanite. Analyses made by Mr. H. Jackson gave to Jordanite the ordinary formula, $4PbS.As_2S_3$, and to Rathite the formula, $3PbS.2As_2S_3$.—Mr. L. J. Spencer described complex twinned crystals of Stannite on specimens from Bolivia collected by Sir Martin Conway. The crystals appear to be tetragonal, with crystal element close to that of copper-pyrites. The analysis by Mr. G. T. Prior tends to confirm the usually accepted formula.

Royal Meteorological Society, November 15.—Mr. F. C. Bayard, President, in the chair.—Mr. R. H. Curtis read a paper on the diurnal variation of the barometer in the British Isles. The principal features of a curve exhibiting the diurnal march of barometrical pressure are two minima and two maxima—the first minimum occurring early in the morning and the second in the afternoon, while the first maximum falls in the forenoon and the second not far from ten o'clock in the evening. In the tropics the oscillation may amount to as much as a tenth of an inch, but its amplitude decreases as the latitude increases, and the greatest amplitude in the British Isles amounts to not much more than three-hundredths of an inch. The author discusses the mean hourly readings of the barometer from twenty-five years' observations, 1871–95, at four observatories maintained by the Meteorological Council, viz. Kew, Aberdeen, Falmouth and Valencia. The author is of opinion that the primary cause of the diurnal oscillation of the barometer is solar radiation, and that its amplitude is chiefly determined by the temperature of the lower strata of the atmosphere. The relative magnitudes of the different phases of the barometer oscillation, as observed, depend largely upon the geographical position and physical surroundings of the place of observation, in so far as these are capable of modifying its temperature conditions, and especially the relative distribution of temperature over the regions immediately surrounding it.—Mr. G. J. Symons, F.R.S., described some experimental observations which he made during the hot weather in July with two thermometers one foot below the surface of the ground, with the view of ascertaining (1) the influence of slight shade, (2) the amount of daily range, and (3) the approximate curve of daily fluctuation.

PARIS.

Academy of Sciences, November 20.—M. van Tieghem in the chair.—Note on the Leonids, by M. Lœwy. An account of the results obtained in various French observatories on the Leonid swarm. The results were disappointing. At Paris only thirty-three Leonids were seen on three nights; at Algeria, sixty-five in two nights; at Lyons, forty during three nights; at Toulouse, forty-three. The most favourable conditions for observations appear to have existed at Marseilles, where twenty shooting stars were seen on the night of the 13th, seventy-one on the 14th, and forty-three on the 15th, or 134 in all.—Note on the observations of the shooting stars known as the Leonids, made at the Observatory of Meudon, by M. J. Janssen. In order to prevent the possible interference of clouds or fog with the observations, two balloons were employed, at an altitude of about 200 metres. Full details will be given in a later paper.—On the course of a system of plane waves, laterally indefinite, moving in an isotropic heterogeneous medium, formed of plane parallel layers, by M. J. Boussinesq.—Action of fluorine and hydrofluoric acid upon glass, by M. Henri Moissan. The statement of Louyet, that anhydrous hydrofluoric acid does not attack glass is shown to be based upon a misconception, since although under certain conditions glass maintains its polished surface in contact with hydrofluoric acid, it can be shown to have been attacked by its loss of weight. In the present experiments glass was invariably found to be attacked at the ordinary temperature by gaseous hydrofluoric acid, even although very carefully dried. In the first experiments made with fluorine, a similar effect was observed; but this was afterwards found to be due to the presence of a minute trace of hydrofluoric acid. Pure fluorine, freed from traces of acid by passing through a V-tube cooled in liquid air, may be kept in sealed glass bulbs for weeks without the glass being attacked.—Observations of the Leonid swarm of November 13 to 16, 1899, made at the Observatory of Paris, by M. G. Bigourdan.—Observations of Leonids at the Observatory of Toulouse, by M. Baillaud.—Observation of the Leonid swarm at the Observatory of Meudon, by M. H. Deslandres.—Observations of the new planets (E W) and (E R) made at the Observatory of Algiers with the 31·6 cm. equatorial, by MM. Rambaud and Sy.—Observations of the sun made at the Observatory of Lyons during the second quarter of 1899, by M. J. Guillaume. The results are collected in three tables, showing the number and area of spots, distribution of the spots in latitude, and of the faculæ in latitude.—Contribution to the theory of the function $\zeta(s)$ of Riemann, by M. Edm. Landau.—On systems simultaneously isolated, by M. Andrade.—A new theory of the optical phenomena of the entanglement of ether by matter, by M. G. Sagnac.—On a new binocular lens, by M. Émile Berger.—Chemical effects produced by the Becquerel rays, by M. P. Curie and Mme. Curie. Radio-active barium chloride possesses the property of converting oxygen into ozone. This necessitates an expenditure of energy, and hence is a proof that the radiation represents a continual disengagement of energy.—Reciprocal displacement of metals, by M. Alb. Colson. The disturbing effects of oxygen and occluded gases were eliminated in these experiments by working in a Crookes vacuum. It was found that the reactions

$$Hg_2Cl_2 + 2Ag = 2Hg + 2AgCl$$

and

$$AgS + Hg = HgS + Ag$$

are reversible, the reaction being limited by a definite pressure of mercury vapour for a given temperature.—Action of nitric oxide upon chromic dichlorhydrin, by M. V. Thomas. Nitric oxide combines vigorously with chromyl dichloride, giving an amorphous compound, the results of the analysis of which can be best expressed by $Cr_5Cl_5O_7.2NO_2$.—On a methylene sulphate, by M. Marcel Delépine. By the interaction of dry trioxymethylene and fuming sulphuric acid, a neutral crystallised substance, $CH_2O.SO_3$, is obtained, thermochemical data for which are given.—On a mode of synthesis of parabanic acid, by M. P. Cazeneuve. Oxamide added to boiling phenyl carbonate gives parabanic acid and phenol, the acid being identified by means of its silver salt. The yields do not exceed 5 per cent. of the oxamide employed.—On a new Myxosporidium, *Nosema Stephani*, a parasite of *Flesus passer*, by M. Hagenmuller.—On the cytological phenomena preceding and accompanying the formation of the teleutospore in *Puccinia Liliacearum*, by M. R. Maire.—On the histological modifications produced in stems by the action of *Phytoptus*, by M. Marin Molliard. The chemical action which corresponds to the presence of parasites such as *Phytoptus* determines the formation of a new tissue which differentiates itself at the expense of any cells, independently of what these cells would have become in the ordinary course of development.—On the negative variation of the axial nervous current, by M. Mendelssohn.—The cryoscopy of urine as an aid to diagnosis, by MM. H. Claude and V. Balthazard.—Effect of a diet poor in chlorides upon the treatment of epilepsy by sodium bromide, by MM. Ch. Richet and Ed. Toulouse. The use of sodium bromide in the treatment of epilepsy, although efficacious to a certain extent, leads to other troubles owing to the large doses necessary, 8 to 15 grams per day. By the use of a diet as free as possible from salt, equally good effects were produced with only 2 to 4 grams of sodium bromide daily. The special diet appears to have no effect upon the general nutrition.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Bridges for Light Railways: L. H. Rugg.

FRIDAY, DECEMBER 1.

GEOLOGISTS' ASSOCIATION, at 8.—The Zones of the White Chalk of the English Coast. I. Kent and Sussex: Dr. A. W. Rowe.—A New Rhætic Section at Bristol: W. H. Wickes.

MONDAY, DECEMBER 4.

SOCIETY OF ARTS, at 8.—Enamelling upon Metals: H. H. Cunynghame.
SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Fireproofing and Preserving of Timber: Sherard Cowper-Coles.
VICTORIA INSTITUTE, at 4.30.—Pictorial Art among the Australian Aborigines: R. H. Mathews.

TUESDAY, DECEMBER 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: The Waterloo and City Railway, and its Electrical Equipment.——*Paper to be read with a view to discussion*: Combined Refuse-destructors and Power-plants: C. Newton Russell.

WEDNESDAY, DECEMBER 6.

SOCIETY OF ARTS, at 8.—Artificial Silk: Joseph Cash.
GEOLOGICAL SOCIETY, at 8.—On the Occurrence in British Carboniferous Rocks of the Devonian Genus *Palaeoneilo*, with a Description of the Species *Palaeoneilo carbonifer*: Dr. Wheelton Hind.—On the Geology and Fossil Corals and Echinids of Somaliland: Dr. J. W. Gregory.—Note on Drift-gravels at West Wickham, Kent: G. Clinch.
SOCIETY OF PUBLIC ANALYSTS, at 8.—Note on Asafœtida: C. G. Moor.—On some Analyses of Modern Dry Champagne: Dr. P. Schidrowitz and Dr. Otto Rosenheim.—On the Determination of the Iodine Value: Dr. J. J. A. Wijs.—Treacle or Golden Syrup: E. W. T. Jones.—On a Method for Distinguishing between Hops and Quassia: Alfred C. Chapman.
ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, DECEMBER 7.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Vapour-density of Bromine at High Temperatures: Dr. E. P. Perman and G. A. S. Atkinson.—Polytremacis and the Ancestry of Helioporidæ: Dr. J. W. Gregory.—Gold Aluminium Alloys: C. T. Heycock, F.R.S., and F. H. Neville, F.R.S.—On the Association Attributes in Statistics; with Examples from the Material of the Childhood Society, &c.: G. U. Yule.—Data for the Problem of Evolution in Man. III. On the Magnitude of certain Coefficients of Correlation in Man, &c.: Prof. Karl Pearson, F.R.S.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Cost of Steam Raising: John Holliday.—Influence of Cheap Fuels on the Cost of Electrical Energy: R. E. Crompton. (Adjourned Discussion.)
LINNEAN SOCIETY, at 8.—On some Vegetable Poisons used for the Capture of Fish by the Australian Aborigines: J. W. Fawcett.—On some New Zealand Schizopoda: G. M. Thomson.—On the Structure of Porites: H. M. Bernard.
CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Oxidation of certain Organic Acids in presence of Iron: H. J. H. Fenton, F.R.S., and H. O. Jones.—The Determination of the Constitution of Fatty Acids, Part II.: Dr. A. W. Crossley and H. R. Le Sueur.—On Sulphates of the Form R'_2SO_4, $2M''SO_4$, especially those of Isometric Crystallisation: F. R. Mallet.
RÖNTGEN SOCIETY, at 8.—Observations on Practical X-Ray Work, with Exhibition of Apparatus and Stereoscopic Skiagrams: Mackenzie Davidson.—Bullet in the Brain: J. Moore.

FRIDAY, DECEMBER 8.

ROYAL ASTRONOMICAL SOCIETY, at 8.

CONTENTS. PAGE