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" *To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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INDEX.

Reviews and Our Bookshelf.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, NOVEMBER 4, 1909.

MODERN WELDING.

Welding and Cutting Metals by Aid of Gases or Electricity. By Dr. L. A. Groth. Pp. xvi+281. (London: A. Constable and Co., Ltd., 1909.) Price 10s. 6*d*. net.

THE art of welding iron is very old, probably as old as the production of the metal from its ores. Previous to the nineteenth century the art of forging and welding iron reached a high stage of development. Then came the cast-iron period, which for a time usurped the place of the forged metal. But during the last half-century, owing to improved and less costly methods of production and the introduction of machines which can make forgings of a size far greater than can be worked by a smith, new methods of welding have become necessary. Welding of the metals has kept pace with the improvements in metallurgy, and a great part of it is now carried out by fusion; consequently, joins of almost any thickness can now be made, whereas by the method of hand hammering the size and thickness of the joins was very limited.

The book before us deals with the welding of metals mainly by the newer methods which have been made possible by the advance in electrical science and by the use of reducing flames of high temperature, such as hydrogen and acetylene. But not only can high-temperature flames be employed for welding; they can also, by altering the conditions, be used for cutting thick plates of metal. Whereas, however, the welding is carried out by means of flames containing an excess of a reducing gas, the cutting is done by means of flames rich in oxygen.

The book commences with a short introduction explaining the nature of a weld. Chapter ii. is headed "Gases and Sources for their Generation." One hardly knows what to make of this chapter; if it is written for the novice it is useless, if written for the chemist unnecessary. We are told, in the first place, "it has been known for ages that matter is capable of existing in three physical states: the solid state, the liquid state and the gaseous state."

Further on there is an historical account of the manufacture of calcium carbide and of the preparation of acetylene. It is a pity that this part of the book is not written in a manner to help the welder or cutter, and is not always accurate. What, for example, does this mean?

(Hydrogen) "is usually prepared by the action of zinc or iron on a solution of hydrochloric or sulphuric acid. All metals which readily decompose water when heated readily furnish hydrogen on a similar treatment. Many other acids may be used, *but none cut more readily*. In all cases the action consists in the displacement of the hydrogen . . . and if the acid is not one which can enter into reaction with the displaced *nitrogen*, the latter is evolved as a gas."

Poor novice! Again, hydrogen was not liquefied by Cailletet on December 30, 1877.

From chapter iii. and onward the book is interesting and instructive. Welding and the different systems employed are described—thus autogenous, or the union of the metals by direct fusion; under this we get alumino-thermic processes, electric welding, welding with compressed gases. Heterogeneous, in which a foreign metal or alloy is employed, which has a lower melting point than the metals to be joined.

The welding of aluminium, which is similar to lead burning, is described, and illustrations are given to show that, as a rule, the tensile strength of a welded bar is greatest at the weld, or, at any rate, breaking does not take place at this position. The aluminothermic process is well described, and two interesting diagrams showing the mending of cracks in the stern frame of a steamer are shown.

A considerable amount of space is devoted to electric welding, which has been found so useful in the welding of pipes and tubes; very interesting illustrations showing the joining of pipes to form T's and other unions are given.

Chapter iv. deals with blow-pipes of various design which are used for different purposes. We are not particularly impressed with the insertion of advertising letters in chapter v. This chapter deals with the welding of sheet-iron, and various methods are described. But surely it should not be necessary to print letters from the Public Works Department of Perth, W. Australia, and from other bodies, writing in appreciative terms of a certain process which, as we are not advertising it, we need not mention. To our mind, in book-writing the author should use his own judgment, which may or may not be influenced by letters of recommendation, but it says little for his analytical skill if he finds it necessary to print the letters.

The part of the book dealing with the welding and cutting of metals is extremely interesting, and illustrates the great advance which has recently been made in this direction. In all autogenous processes a reducing flame which prevents the formation of oxides is a *sine qua non*; but when a flame is to be used for cutting purposes the reverse is the case. Most metals, when heated to a sufficiently high temperature, will burn in oxygen. This property is made use of in cutting steel, for example. An oxy-hydrogen flame is caused to impinge upon the metal, and at the same time an auxiliary blow-pipe directs oxygen gas upon the heated surface; immediate combustion ensues. The stream of oxygen is sufficiently powerful to drive away the oxide as it is formed, and the cutting progresses very rapidly. For example, an armour plate 6·3 inches thick was thus cut to a length of 1 metre in ten minutes. At Bremen a similar process has been employed for cutting up and scraping ships.

The book is suggestive, useful, and will, we hope, enjoy a large circulation in spite of the few errors here pointed out, and when the second edition is being prepared we trust the author will take notice of our friendly criticism.

F. M. P.

PROBLEMS IN NUTRITION.

Volksernährungsfragen, and *Kraft und Stoff im Haushalte der Natur*. By Prof. Max Rubner. Pp. iv+143 and 181 respectively. (Leipzig: Academische Verlagsgesellschaft, 1908, 1909.)

THESE two little books contain three useful and readable essays on those nutritional problems to which Prof. Max Rubner has directed most of his research work. The first of the above-mentioned books contains two of these, and they treat of the minimum protein requirement of man and of diet of the poor respectively. The first question has within recent years been brought prominently before the scientific world, as well as the public at large, by the work of Chittenden and others, who argue from their experiments that, because they themselves have been able for limited periods to maintain their health and equilibrium on an amount of protein which is far below the usually accepted Voit minimum, therefore all men should permanently reduce their intake of protein to the same low level. Those who believe that the minimum is also the optimum would do well to read and consider carefully the Berlin professor's judicial commentary on their views.

What most strikes the reader is the extraordinary complexity of the problem. One factor, however, is absent, and that is the effect of work and rest, for this causes practically no effect on the metabolism of protein matter; but the question is sufficiently complex without this. There is between different people an enormous variation in what one may term their metabolic habits, so that any hard and fast rule is impossible. The mere body weight is not an important element, although, naturally, the heavier a man the more protein will he require. If this were all, it would be easy to adapt the dosage to the body weight; but the difference is deeper than this; to mention one point only, it is shown that, as a rule, the thin person requires more protein to maintain nitrogenous equilibrium than the corpulent. It must have been a matter of common observation that the stoutest people are not the biggest eaters. Another complicating factor is what one eats with the protein, and also the kind of protein one ingests. It is shown that on a potato diet, for example, the minimum necessary to maintain nitrogenous equilibrium is less than with any other of the diets adopted. We have further to take into account the presence, in most foods, of nitrogenous substances which are not protein, but which, nevertheless, have to be reckoned with.

The second essay, on the diet of the poor (agricultural labourers and the like), emphasises very clearly one reason why a low protein intake brings the consumer dangerously near to the margin. It is shown beyond question that such a diet renders people much more prone to take infectious diseases, and there is a general lowering of the powers of resistance. Considering that the bulk of the population consists of those who are not well to do, this becomes a matter of national importance, and it is the duty of the State to interfere. Prof. Rubner appears to think that legislative measures should be adopted. We can see, however, that the difficulty of legislating on such a matter is very great; but at least the people should be educated on the question of feeding rationally, especially where children are concerned. Anyone with any experience of hospital patients knows that ignorance, in addition to poverty, is at the bottom of most of the conditions of malnutrition which meet us at every turn. Ignorance, moreover, is not confined to the poor in regard to this most important question.

The third essay, which occupies the second volume, is a summary of Prof. Rubner's work on nutrition generally; it is written in a more popular manner than most of his publications, and a distinct philosophical vein runs through it. The chemical events which occur in the living body fall mainly into two categories—(1) those due to the activity of enzymes; in these there is but little transformation of energy; and (2) those which may roughly be described as combustion, and from which the energy of living and doing is derived. It is the second class of chemical changes to which Prof. Rubner has mainly directed his attention, and it is to him, in particular, that we owe the experimental proof that the law of conservation of energy applies to the living cell as well as to the world of inorganic matter. The law of the conservation of energy is so universal that one might, perhaps, have assumed it would hold for living as well as for lifeless material. But the scientific mind assumes nothing without direct proof; we have no right to assume beforehand that some other law might not be found operating in the organic world. The crude calorimetric researches of Lavoisier and the early pioneers of this subject certainly showed great discrepancies between the results obtained and those calculated from the energy value of the diets employed; but as technique has improved so has it been shown that all such discrepancies were the result of imperfection in the methods used. For the improvements in method, and the patient working out of the problem as well as the final demonstration of the truth of the great law of energy conservation in the world of life, there is no one to whom we owe more than to Prof. Rubner himself.

W. D. H.

COLOUR MANUFACTURE.

A Treatise on Colour Manufacture. A Guide to the Preparation, Examination, and Application of all the Pigment Colours in Practical Use. By George Zerr and Dr. R. Rübencamp; authorised English edition by Dr. Charles Mayer. Pp. xiv+605. (London: C. Griffin and Co., Ltd., 1908.) Price 30*s*. net.

THIS volume is the most complete publication on colour manufacture which has yet been produced in English. After dealing with the general preparation of materials, and describing the various types of grinding and sifting machines, in part ii. the manufacture of artificial mineral colours in dealt with in a very thorough manner, although in certain details inaccuracies are, as is to be expected, to be found.

Part iii. deals with the raw materials used in colour making, their properties, adulterations, and tests for purity. This section should prove very valuable in many colour works where the raw materials are bought in large quantities, and reliable information of this kind will enable them to be readily examined to test their purity.

The natural mineral colours and black pigments are then dealt with, and following upon this is a description of organic colouring materials and their utilisation in making lake pigments. The first section deals with natural organic substances, while the second section deals with the application of the coal tar colours to the manufacture of lakes. This section should prove of considerable value to colour makers, as it contains a scientific classification of the coal tar derivatives, and so reveals the principles upon which such lakes must be prepared. It is, of course, impossible that such a treatment of the subject should be up to date, as fresh coal tar products and fresh methods of obtaining trustworthy lakes from them are constantly being produced, but a study of these chapters will give the student a thorough grip of the principles underlying the manufacture of these lakes, and some interesting information will be found at the end of this section of the book on the reactions of the more important lakes from artificial colouring materials, which should be of use to those who wish to match samples that have been submitted. There is also a brief account of the use of pigments in different ways which, while very general in character, contains some very interesting information.

In the appendix will be found a table of solubilities of many of the salts used by the colour maker, in cold and in hot water, which should prove of practical value, while there are in addition specific gravity tables for a certain number of these salts which should also be of use.

As has been stated, there are certain errors in detail to be noted, more especially in connection with the finer colours which are used for artists' purposes, and two of these which happened to have caught the eye of the reviewer may be pointed out. On page 154, Indian yellow is incorrectly described as being the same thing as cobalt yellow, Indian yellow being a preparation of euxanthic acid obtained from India, and cobalt yellow is described as being not very fast to air and light, while, as a matter of fact, it is one of the most permanent pigments to be found in the artist's palette. Again, under blue colours on p. 203, cobalt blue is spoken of as being now of no technical value. Considering the very large use of cobalt blue by artists and for superior decorative purposes, this statement is scarcely justifiable. The description of the manufacture of cadmium yellows is also very far from complete, and no doubt other similar small errors could be found throughout the book, and are inevitable in a work of this kind.

A more serious defect is one which is to be found in a great many works on colour manufacture. While elementary information on qualitative and quantitative analysis is published—see, for instance, the discussion of the methods of volumetric analysis on p. 343—information which it is only right to suppose is perfectly familiar to the modern colour maker and colour chemist, and simple qualitative tests are given which are to be found in all elementary books on qualitative analysis, little information is supplied as to the complete analysis of modern pigments. Such information would be of value even to the skilled analyst, who, when he comes across some pigment, wishes to know the probable defects to look for, the kinds of adulteration likely to be present, and the most rapid manner of handling with a view to making a sufficiently complete analysis for practical purposes. Some attempt to deal with this problem was made by Hurst in his book on pigments, but a more complete scientific handling of the subject is very much required.

In conclusion, this book may be safely recommended to all those interested in colour manufacture, as containing a great deal of useful and valuable information brought together in a clear and practical form.

UNIVERSITY ADMINISTRATION.

University Administration. By Charles W. Eliot. Pp. 266. (London: Constable; Boston and New York: Houghton, Mifflin and Co., 1909.) Price 6*s*. net.

UNIVERSITY politics has long been a current phrase, and questions of university government and policy have been increasingly discussed of recent years; yet, in spite of the rapid increase in the number of the English universities, and of the many interesting experiments in organisation which they embody, there has so far been no comprehensive treatise written in this country upon university administration. The gap is now filled, though from the other side of the Atlantic, by the late president of Harvard, who has condensed his thirty-nine years of experience as the ruler of the most famous of the American universities into a book which will long rank as the standard authority on the subject. Written with admirable clearness and precision, it states and discusses sensibly and practically problem after problem with which English readers are familiar in newspaper discussions on university reform, but which it is not easy to see in their wider bearings.

The book is divided into six chapters, which deal successively with university trustees, inspecting and consenting bodies, faculties, the elective system, methods of instruction, concluding with a chapter on the social organisation of a university, the position of the president, and several questions of general administration.

The most novel and interesting chapter in the book is undoubtedly that on the elective system, the introduction of which at Harvard has been the main feature of President Eliot's *régime*, and which he is at pains to explain and defend. He describes it as a "carefully arranged scheme of numerous courses of instruction which are open to the choice of students under rules partly artificial but chiefly natural and inevitable." Its effect is to give the individual student, not unlimited, but still far more extensive opportunities of "following his bent" in the choice of his university course than he gets under the fixed courses in subjects or groups of subjects which are usual in English universities. President Eliot claims that, if strictly administered, it satisfies the needs of serious students with intellectual initiative of their own who are apt to feel cramped by a rigid college course, while for the mediocre and unambitious it offers the "only chance of experiencing an intellectual awakening while in college." At the same time, it gives every teacher the precious privilege "of having no student in his class who has not chosen to be there." Its main difficulty is, of course, that it is very much more expensive than the "prescribed" system.

President Eliot's two chapters on university government will be read with interest in this country, especially in view of Lord Curzon's recent book on the government of Oxford, which, written from a wholly different standpoint, affords a striking illustration of some of Prof. Eliot's views. Harvard, which President Eliot regards as "the university with the most fortunate organisation in the country," is governed by a body of trustees, seven in number, controlled by a body of thirty overseers, elected by the whole body of Alumni, who exercise, through visiting committees and otherwise, powers of inspection and veto. The overseers thus play the part of the whole body of M.A.'s of Oxford and Cambridge, only with vastly increased efficiency, because they are a representative committee, and not an unorganised mob periodically assembled by a whip. Lord Curzon's recent proposal to constitute at Oxford a new finance board of eight or ten members, partly non-residents, to exercise a general control over college and university finance, is thus clearly on the lines of the American boards of trustees; but President Eliot's book throws no light, of course, on the main difficulty of university organisation in the older universities, the relation between the university and the wealthy and autonomous collegiate corporations which have grown up in its midst.

PROBLEMS OF IMMORTALITY.

Unsterblichkeit: eine Kritik der Beziehungen zwischen Naturgeschehen und menschlicher Vorstellungswelt. By Hermann Graf Keyserling. Pp. iv+349. (München: J. F. Lehmanns Verlag, 1907.)

COUNT KEYSERLING has chosen a subject upon which the views even of a dull man are frequently interesting, if only as a "document," and he has treated it in a manner that makes his book a notable contribution to its serious study. He is broad-minded and well informed; he develops his argument lucidly and consecutively, and he illuminates it with considerable literary grace.

An examination of the data of the famous argument for immortality which appeals to the consensus of mankind, *semper et ubique*, shows that, in reality, it gives no support to any specific form of the doctrine. The concepts of future existence described by ethnologists and historians differ enormously, not only in detail, but even in principle. If, then, we continue (as does the author) to attach importance to the consensus, we must regard it as giving a merely formal guarantee of some kind of post-vital permanence which it is impossible to specify. To be assured that it has this value requires a critical examination of the nature and functions of faith (*Glaube*). Faith is to be identified neither with an unverified belief in matters that may eventually become the objects of certain knowledge, nor with a confidence in things of which certain knowledge is, by the nature of the case, impossible; it is a specific activity of the soul in which it fastens upon, or recognises, the ultimate assumptions of a causal or logical nexus. It is by faith that I recognise the validity of a geometrical axiom, the existence of God, the reality of the objective world, and the correlated reality of my own subjective existence. I may be mistaken in the particulars of my assumptions under any one of these heads—as I am, for instance, in perceptual illusion—but in no case can my final certainties rest upon any other ground than faith. The possibility of error in the contents to which faith attaches merely illustrates its purely formal character as an epistemological function. It follows from this definition that faith is not a temporary phase, but a permanent and essential constituent of the human movement along the lines both of thought and of action. There is, in fact, a "conservation of faith" within the subjective world analogous to the conservation of energy in the physical world—the one regulating our recognition of Being much in the same way that the other regulates our recognition of Becoming.

Examining the character and contents of human experience by the aid of this theory of faith, the author finds that it yields no support to the belief in a continued personal existence. On the contrary, he detects in the moral consciousness a recognition that the permanent element in us is an Entelechy that produces our "personality" as a purely temporary phenomenon, and will in due time pass upon its way. It draws from an underlying sea of infinite, unimaginable Being, and our individualities are, as it were, merely the waves in which, from moment to moment, the ceaseless movement of this sea expresses itself.

It is unlikely that the reader will be able to agree with all Count Keyserling's views; in particular, he will probably feel that the concept of faith as a purely formal function is by no means clear. His dissatisfaction with this part of the argument will not, however, interfere with his appreciation of the ability with which the author has conducted his inquiry and of the stimulating manner in which he has presented his results.

T. P. N.

DESCRIPTION OF NEW MINERALS.

Second Appendix to the Sixth Edition of Dana's System of Mineralogy. By Edward S. Dana and William E. Ford. Pp. xii+114. (New York: John Wiley and Sons; London: Chapman and Hall, Limited, 1909.) Price 6s. 6d. net.

THE debt of gratitude that mineralogists, and, indeed, all interested in the physical and chemical characters of the inorganic products of nature, owe to the Danas, *père et fils*, is immense, and can scarcely be realised owing to the human propensity to take for granted all that is provided to hand. The task of compiling such a compendium is without ending. Mineralogy, like all branches of science, does not stand still, and no sooner has an edition appeared than it begins to need expansion and revision. The larger a work of this character becomes, the greater is the difficulty in bringing out fresh editions at short intervals; yet something must be done if pace is to be kept with the growth of mineralogical science. In the present instance the problem has been solved by the issue of a series of appendices. The last edition, which was the sixth, of the "System of Mineralogy," was produced by Prof. E. S. Dana in 1892; the first appendix was issued in 1899, and now, ten years later, the second appendix has appeared.

In the present volume the same plan has been followed as in the first appendix. It opens with a list of the principal works that have been published within the period dealt with, and a list of new mineral species classified according to the arrangement of the system. The rest of the book is occupied with a concise but complete description of the important characters of the new minerals, such as the crystallographical and optical constants, the values of the principal angles, the colour, the specific gravity, the chemical composition and the response to the ordinary reagents, and the locality whence they were obtained; and, further, with an abstract of work that has been done on species previously known. The alphabetical arrangement renders it easy to look up any species, and the reference to the original paper, which is in all cases given, enables the information to be traced to the source. We regret to learn from the preface that the continuous strain proved too much for Prof. Dana, and his breakdown in health nearly three years ago compelled him finally to relinquish the work. Fortunately he had at hand a colleague, Prof. Ford, who was able to complete it for him. Lack of time, however, prevented the course, followed in the "System" and in the first appendix, of re-calculating from the data the crystallographical constants and the important interfacial angles being strictly adhered to.

The rate of discovery of new mineral species shows no sign of abatement, contrary to what might have been expected. The present volume includes about sixty definitely new species. It would, indeed, appear as if any careful search in new or little-known localities could not fail to be fruitful in bringing to light new species. Thus this volume includes descriptions of the interesting results of Dr. Flink's collecting trip to Greenland, many of Mr. Solly's remarkable discoveries in the famous Lengenbach quarry near Binn, the new mercury minerals from Terlingua, and the curious zinc phosphates from the Broken Hill mines, Rhodesia.

G. F. H. S.

OUR BOOK SHELF.

Principles of Reinforced Concrete Construction. By F. E. Turneaure and E. R. Maurer. Pp. x+429. Second edition, revised and enlarged. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 15*s*.

IN this edition a considerable number of changes have been made, and much new material has been added. In every case records of experiments have been brought right up to date: this is especially the case in regard to the adherence between the concrete and the reinforcing metal, to the shear strength of beams, and to the strength of columns. The properties of concrete and steel are fully dealt with in chapter ii. The important question of the value of the modulus of elasticity of concrete is discussed in the light of the most recent experiments. The authors are of opinion that for most calculations in regard to strength the value of the modulus should be taken as 2,000,000 lb. per sq. in. The tests on bond by Mr. Withey seem to show that the intensity of the bond per square inch is not affected by the size of the bars, and that the average bond strength as determined by direct tension is much higher than in the case of beam experiments. The difficulty of carrying out these latter tests prevents their more usual adoption. In determining the strength of reinforced-concrete beams, the authors have wisely, for the greater part of the book concerned with this problem, assumed that the stress-strain curve for concrete is practically straight within the limits of the working stresses adopted in practice; in sections 60 to 70 they have, however, deduced a series of flexure formulæ on the assumption that the stress-strain curve is a parabolic arc. In both cases the concrete is assumed not to take any tension. Engineers engaged in structural work involving the use of this material for transverse loads can, therefore, check their results by both sets of formulæ, and thus secure an additional guarantee of the security of their design. Designers learn almost as much from the results of carefully conducted experiments as they do from all the formulæ that fill the various text-books, and it is satisfactory to find a whole chapter devoted to a description and a discussion of a carefully selected series of rupture tests of both beams and columns.

In dealing with working stresses, the authors discuss the respective advantages and disadvantages of the "working stress" method, and the "factor of safety" method; they incline to the use of the latter in the present case. The whole question is discussed in a thoroughly practical and satisfactory manner in chapter v., especially from the point of view of economy. The last portion of the book deals with the design of reinforced concrete members, and the arrangement of connective details—floors, cross-beams, columns, footings, arches, and retaining walls are all treated in some detail, with numerous excellent dimensioned illustrations—and a complete chapter is given up to the design of chimneys. The fact that this book has already reached a second edition is a proof that it meets a want, and it is also a proof of the rapid spread of the use of reinforced concrete for all kinds of structural work. T. H. B.

The Influence of Heredity on Disease, with Special Reference to Tuberculosis, Cancer, and Diseases of the Nervous System. A Discussion opened by Sir W. S. Church, Bt., K.C.B.; Sir W. R. Gowers, F.R.S.; Dr. A. Latham; and Dr. E. F. Bashford. From the Proc. Roy. Soc. of Medicine, 1909, Vol. II. Pp. xii+142. (London: Longmans, Green and Co., 1909.) Price 4*s*. 6*d*. net.

THIS volume embodies an important discussion held by the Royal Society of Medicine, and, in view of the importance in determining the influence of heredity as an ætiological factor in the production of disease, the council of the Society has been well advised to publish it separately, as well as in its Transactions, and thus render it accessible to all.

Many eminent names appear and give the weight of their authority to the facts quoted. Sir W. Gowers, Dr. Savage, Dr. Mott, and Dr. Mercier dealt with heredity in connection with nervous and mental diseases; Dr. Latham and Dr. Bashford gave the opening addresses on heredity in tuberculosis and in cancer respectively; Sir John McFadyean dealt with the inheritance of disease among the domestic animals; Prof. Bateson and Mr. Mudge discussed the subject from the biological, and Prof. Karl Pearson from the biometrical, standpoint.

Mendelism naturally occupied a prominent place in the discussion, and great difference of opinion was expressed regarding it. For instance, Prof. Pearson states that "there is no definite proof of Mendelism applying to any living form at present; the proof has got to be given yet."

The pedigrees of many abnormal conditions given by various speakers seem to indicate that much further information is required before we shall be in a position to accept Mendelism, or indeed any other hypothesis of the laws of heredity. In fact, the main results brought out by this discussion would appear to be, first, that medical men and biologists should acquire a working knowledge of statistical methods; and, secondly, that for the next few years a careful collection should be made of pedigrees of abnormal conditions—such as albinism and night-blindness—so that eventually sufficient data may be acquired for proper analysis.

The Campaign against Microbes. By Dr. Étienne Burnet. Translated from the French by E. E. Austin. Pp. xi+248. (London: John Bale, Sons and Danielsson, Ltd., 1909.) Price 5*s*. net.

THE author, in our opinion, has missed an opportunity for presenting to the general public an account of the present-day campaign against microbes and microbial diseases. Malaria, Mediterranean and enteric fevers, dysentery, diphtheria, and plague are not referred to, yet how much is now being done to mitigate the ravages of these human pestilences! On the other hand, one-fourth of the book is allotted to cancer, the microbial nature of which at present is, to say the least, discredited; and the essential preventive measures against this disease, so far as we know them, are omitted—*e.g.* the education of the public at once to seek medical advice if a tumour or swelling or abnormal discharge be noticed, and the immediate treatment of all forms of chronic irritation in and after middle life.

Tuberculosis, tetanus, sleeping sickness, enteritis and intestinal microbes, and small-pox and vaccination are the other subjects dealt with. As regards tuberculosis, a great deal is said about the vaccination of cattle, yet how little has this so far been applied practically? Tetanus, again, fearful as it is in individual cases, is not of much importance to the community as a cause of death. In the section on enteritis and intestinal microbes, the sour-milk treatment is rightly extolled, but to the exclusion of other matters, and the section on small-pox is mainly a history of Jenner's discovery. The book, therefore, while interesting and instructive so far as it goes, is disappointing, and seriously wanting as an exposition of the modern crusade against infective diseases.

The translator seems to have done his work well, but might in places have incorporated the results of recent research. R. T. HEWLETT.

Brazil in 1909. By J. C. Oakenfull. Pp. 237. (Brazilian Government Commission of Propaganda and Economic Expansion. Paris, 1909.)

A COUNTRY sixteen times the size of France, with a population barely half as numerous, a country teeming with mineral wealth, favoured with majestic river-systems, and climates capable of producing everything needed by man, boasting, too—at least on paper—a body of laws unsurpassed anywhere in their broadminded liberality—such is the theme Mr. Oakenfull has undertaken to expound. An immense undertaking, indeed, were it set out in all possible fulness of detail; but when compressed into some two hundred pages, requiring a tactful hand to give each subject its due space and no more. This task of selection has been carried out well. Publicists, financiers, miners, pastoralists, agriculturists, and tourists will all find their requirements catered for. The best chapters are those devoted to mineralogy and applied botany; but, as so often happens when the writer is not an expert botanist, a sad hash is made of some of the Latin names. For instance, *Cattleya amethyst oglobossa* is not in the "Index Kewensis," nor do botanists talk of *violaceas* or *bromeliaceas*. For his next edition Mr. Oakenfull should enlist the services of a botanist; he would also do well to revise his composition in places. Moreover, his account of the climate seems to us rather too optimistic; when the heat is moist, in Brazil as in all tropical countries, the conditions are apt to be very enervating. To the student of social phenomena the most interesting part of the book is that dealing with the rapid advances made under the Republic. The inducements to colonists, it may be added, are simply astounding in their liberality. S. M.

LETTERS TO THE EDITOR.

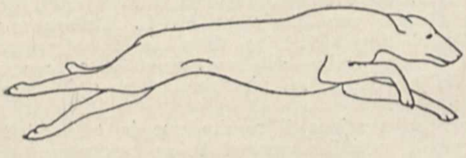
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Gallop of the Horse and the Dog.

IN a note in NATURE of October 28 (p. 526) it is stated that Mr. Francis Ram, in a recent book, says I am in error (in an article lately published by me) in regard to the position of the legs and feet in a running dog.

I have not seen Mr. Ram's book, but I should be glad if you will print the enclosed outline figure of a running dog taken from a series of instantaneous photographs of a running dog by Mr. Edward Muybridge.

The horizontal line AB gives the actual level of the ground below the dog. The figure is one drawn for a book which I have in preparation, and I think has considerable value, since it serves to establish my suggestion that the Mycenæans (who were the originators of the pose of the galloping horse, which was never used by Greeks, Egyptians, Assyrians, Romans, or Europeans, but travelled, as Salomon Reinach has shown, across Tartary to China and Japan, and came from Japan to England at the end of the eighteenth century) did not *invent* the well-known conventional pose, but *observed* it in the dog, and very reasonably, but incorrectly, *applied* it to representations of the horse and other animals which do not really assume that pose. The pose in question satisfies the



artist's judgment even when applied to the horse, because the outstretched position of the hind legs, with upturned hoofs and the forward-reaching position of the fore-legs, do *succeed* one another in the galloping horse so rapidly as to cause, not a continuity of the retinal impressions, but a continuity of the more slowly formed mental appreciations of the positions of the legs.

It is an important fact that the late Prof. Marey, of Paris, did not succeed in photographing the dog with all the feet "off" the ground and the legs in the position shown in Muybridge's photographs, and consequently archæologists have supposed that the Mycenæans imagined the pose as an artistic expression of rapid galloping. It seems to me, on the contrary, certain that they constantly saw and admired this pose in their hunting dogs.

E. RAY LANKESTER.

29 Thurloe Place, South Kensington, October 29.

The Refractivity of Radium Emanation.

WE have read with special interest the communication from Lord Rayleigh in NATURE, October 28 (p. 519), on the determination of the refractivity of gases available only in minute quantity, because we ourselves have been working towards the same end at intervals during the last two years. Our object in view was also the same, viz. the determination of the refractive index of radium emanation; not only for the intrinsic interest of a knowledge of the refractivity in question, but also because of the great probability of the emanation being one of the series of non-valent elements, and the determination would therefore enable us to extend the series of simple integers which has been found by one of us to connect together the refractivities of the other elements in the series.

The extremely minute quantity of emanation available—not more, after undergoing the ordeal of purification, than about one-tenth of a cubic millimetre measured at atmospheric pressure—made it quite clear that the refractometer to be employed must be on a minute scale, and the form which it seemed to us would probably lead to the most accurate results in the circumstances was one on the principle of a Fabry and Perot *étalon*, partly on account of the sharpness of the bands thus obtainable and partly because it is the *double* thickness which constitutes the path difference between successive interfering beams, and consequently the gas contained is utilised twice.

A capillary tube of glass (or fused silica) was sealed at one end, and a transverse hole was drilled passing through the extreme end of the bore. Two parallel faces perpendicular to the axis of the hole were then ground on the tube, and parallel plates of glass (or silica), silvered (or platinised) on the inside, were then cemented on the faces with Coate's cement. For this apparatus we had recourse, as usual, to the excellent workmanship of Messrs. Hilger. The result was a tiny interferometer vessel, 2·271 millimetres long and 0·71 mm. diameter, into which we could compress the emanation through the capillary tube by means of a mercury column in the usual way. When this interferometer was set up in the path of the green beam separated spectroscopically from the light given by a Bastian mercury lamp, and the light passing through was examined through an astronomical eye-piece—the lens system throughout being chosen so as to give best illumination—the interference bands which were obtained were all that could be desired, it being easily possible—when the silvering was of the best thickness—to measure micrometrically to the hundredth part of a band.

The method of a determination, in general outline, consisted in alternately increasing and decreasing the pressure of the contained gas from and back to a practically zero value and observing the number of interference bands which passed over the cross-wire of the micrometer. In order to determine the efficiency of the arrangement, observations were made for the refractivity of air, with the result that we think we are justified in claiming that an accuracy to within about 2 per cent. could be relied upon, so far as the optical part of the experiments is concerned.

The real difficulties begin, however, when we deal with the emanation itself. The rapid generation of impurities, originating in part in the action of the emanation upon the resinous cement employed for fixing the parallel plates, together with the lack of a knowledge of what these impurities are, made it impossible to calculate the index of the emanation from the experimental results, although it was perfectly easy to measure the refractivity of the mixture of gases existing at any time. The only datum known in regard to the composition of the mixture was the approximate percentage of emanation present, this being found by measuring the γ radiation from it. The direction in which the refractivity lies may, however, be inferred with probability from the following observations. Starting with emanation given off from a solution and containing a very large amount of impurity, this was purified, first, by explosion, drying, and absorption of CO_2, and afterwards by freezing in liquid air and pumping off the volatile impurities according to well-known methods. Testing the refractivity from time to time, its value—at first of the order of that of air—did not sensibly rise until the volume was about one cubic millimetre. Continued purification increased the refractivity, and the highest values obtained in our experiments were 0·000840 when the volume was 0·205 mm.^{3} (at atmospheric pressure) and 0·000916 when the volume was 0·128 mm.^{3} measured at atmospheric pressure. The quantity of emanation was approximately the same for both these measurements, and equalled the quantity in equilibrium with 0·178 gram of radium. Of course, if we could assume that the impurities were the same in kind on the two occasions it would be possible to estimate from these data the value for the pure substance, but the failure of this method on many occasions to give consistent results took away all belief in its applicability. For purposes of comparison we may state that the higher of the above values is about twenty-six times the value for helium, while the value for xenon—the highest for any known gaseous element—is twenty times, and for CO_2 thirteen times, the value of helium.

One source of difficulty so long as the available amount of emanation is so small is that the maximum pressure to which it can be raised in the apparatus is only a few (7 or 8) centimetres. The capillary correction thus becomes exceedingly important, and Sir W. Ramsay has given reasons for believing that the capillary behaviour of mercury is quite abnormal in the presence of emanation. Another serious difficulty with which we had to contend was that, under the action of the emanation, the silver (or platinum) through which the light had to pass gradually became opaque. The consequence was that the apparatus had each time to be dismounted after a couple of days, the faces re-polished, re-silvered, and re-installed before a new experiment could be begun. This source of inconvenience would, of course, not be present in apparatus similar to the Young-Arago method employed by Lord Rayleigh or in a Jamin refractometer (which we think is the more satisfactory of the two), but we do not think that it would be possible to obtain an equal optical efficiency with these arrangements.

The amount of success attending these experiments—small though it may seem to be—justifies us in hoping that if the amount of available emanation were increased a few times only an approximate value of the refractivity would be ascertainable. Even at the present time this might be effected by means of a collaboration amongst all those in the United Kingdom who possess large quantities of radium.

In conclusion, we desire to express our thanks to Sir W. Ramsay for generously supplying us with the emanation with which these experiments were made.

ALFRED W. PORTER.
CLIVE CUTHBERTSON.
Physical Department, University College, London, November 1.

Atmospheric Cloudy Condensation.

IN NATURE of October 21 Sir Oliver Lodge, writing on the recent magnetic storm, seems to think that during these storms the sun is emitting electric projectiles which cause the magnetic disturbance, and that these projectiles will, at the same time, affect the rainfall by the influx of "cosmic nuclei." From this, I presume, Sir Oliver means that the electrons passing through our atmosphere will produce ions in the air, and that these ions will become nuclei of condensation, and in this manner may increase temporarily and locally the rainfall. Now, so far as is at present known, it does not seem probable that these electrified nuclei play any part in cloudy condensation. That they can become centres of condensation is not doubted, but before they can act in that way the atmosphere has to become very highly supersaturated.

These ions, therefore, cannot play any part in the condensation unless all the dust in the air be first removed. The question thus becomes, Is there such a thing as dust-free air in our atmosphere? So far as I am aware, no such condition has ever been observed. I have returns of observations made in many parts of the world by different observers, as well as by myself. Some of these tests were made while crossing the Atlantic Ocean, others on the Pacific Ocean. Many were made in this country and in different countries on the Continent. Some were made at sea-level, others up to an elevation of 13,000 feet, but none of these records shows anything like dustless air. Mr. Rankin, in his Ben Nevis report, says "any number less than 100 particles per cubic centimetre is phenomenally small." Mr. E. D. Fridlander, at an elevation of more than 13,000 feet on the Bieshorn, found 157 particles per c.c. In many hundreds of observations made by myself on the Rigi Kulm (6000 feet) nothing quite so low as 200 per c.c. was ever observed. The reports of the observations made on the oceans show the dusty air to be everywhere, and there does not seem to be much chance of ever finding dustless air, at least so low as cloud-level, as the air with least dust is not found in the descending currents of anticyclones, but in the cyclonic areas, where the air is well washed by the rains. It may be further stated, in connection with this subject, that there is no reason for supposing that an increase in the number of nuclei would have any effect on the rainfall, as in nature only a few of the nuclei do all the condensation, while the others remain inactive.

This letter may seem longer than the subject warrants, but my reason for entering so fully into the subject is that the idea is now very generally accepted that ions do form the nuclei of cloudy condensation in our atmosphere. So stereotyped has this theory become that there is not a scientific book recently published in which this subject is treated which does not give this view. Now, so far as our knowledge at present goes, there is no support for this theory, and those who advocate it will require to show that there is ever dustless air at cloud-level. I have elsewhere shown that, even supposing there was dust-free air, clouds would not likely be formed, but the supersaturation would be relieved by the direct formation of rain, as the condensation in the highly supersaturated air would take place on only a few nuclei, which would grow very rapidly to rain-drops.

It is not here contended that the passage of the electrons through our atmosphere will have no effect on the rainfall, only that it has not been shown that there are ever the conditions necessary for the ions so formed to act as nuclei of cloudy condensation. That the electrons may act in some way in determining the coalescence of cloudy particles to form rain-drops seems possible, but, so far as I am aware, even this has not been demonstrated.

Ardenlea, Falkirk. JOHN AITKEN.

Magnetic Storms.

J'AI lu avec le plus grand intérêt dans le No. 2083 de ce périodique la note importante de M. le docteur Chree sur la dernière grande perturbation magnétique du 25 septembre, 1909.

Comme je fais depuis 1882, j'ai cherché de la mettre en relation avec le passage de la grande tache solaire australe qui a été observée, dessinée et relevée à l'observatoire de Catane par l'assistant M. L. Taffara tous les jours depuis l'apparition au bord est le 18 septembre jusqu' à la disparition au bord ouest le 29 septembre, excepté les jours 19 et 22, où l'observation a été empêchée par les nuages.

De nos observations il resulte que la tache doit être passée par le méridien central le 23 septembre, environ à 5h. soir, temps moyen de Greenwich.

Dans la relation de M. Chree n'est pas donné le temps du maximum de la perturbation, parceque les oscillations des appareils magnétiques de l'observatoire de Kew étaient souvent plus amples de ce que pouvaient être enregistrées. En considérant le commencement et la fin des oscillations plus amples, on a les temps 11h. 43m. et 8h. 30m. et la moyenne 4h. 7m.

Si l'on fait la différence avec le temps du passage de la grande tache, c'est à dire sept. 25, 4h.–sept. 23, 5h. = 1j. 23h. = 47h., on a le retard de la perturbation magnétique sur le temps du passage de la tache à la moindre distance du centre du disque solaire, c'est à dire à la moindre distance de la droite qui unit le centre du soleil à la terre.

Ce retard est très peu différent de celui de 45½h. que j'ai trouvé en moyenne pour 8 coïncidences de passages de grandes taches avec le maximum de fortes perturbations magnétiques du premier semestre 1892; ce retard aussi n'est pas trop différent de celui de 42½h. que j'ai trouvé entre le temps moyen du commencement et de la fin de 19 grandes perturbations magnétiques et le temps des passages de grandes taches, ou de grands groupes de taches, d'après les relèvements de M. Maunder de l'Observatoire de Greenwich.

Il serait donc confirmé aussi pour cette grande perturbation magnétique un temps de 40 à 50 heures pour la propagation du soleil à la terre de l'influence ou action solaire sur le magnétisme terrestre; ce qui donnerait une vitesse de 900 à 1000 km. par seconde; c'est à dire une action plus que 300 fois moindre de celle de la lumière et des actions électromagnétiques. Mais cette vitesse pourrait bien être celle des particules émises par le soleil, selon les idées de M. Arrhenius.

Ainsi l'hypotèse corpusculaire de l'influence solaire acquiert toujours une plus grande probabilité.

L'assistant M. le Dr. Horn a fait à l'Observatoire de Catane presque à tous les jours du passage de la grande tache les photographies au spectrohéliographe, mais on n'a pas obtenu autour de la tache des très-grandes masses faculaires.

A. RICCÒ.
Catania, October 10.

High Pressure Spark Gap in an Inert Gas.

FOR some years I have employed a high-pressure spark-gap, such as that described by me in the *Phil. Mag.* for August, 1902, in connection with a Tesla inductive system, and I have experienced considerable trouble arising from the erosion of the spark balls and their supports. They soon become coated with an oxide of the metal employed, and the sparking becomes unsteady. As a cure for this evil, which contributed much to the formation of a bad type of spark, the employment of some inert gas suggested itself to me; and of such gases Mr. C. C. F. Monckton proposed the use of nitrogen, and this gas I now use instead of air. I find that after the continuous use of nitrogen in the spark-gap the balls are but little affected, while the spark through a gas pressure of 50 lb. per square inch is compact and constant in shape, and the yield of the induction apparatus is greatly enhanced. The spark-gap globe is filled to the required pressure from the gas cylinder through a reducing valve, and when it is shut off the pressure is maintained for ten or twelve days nearly up to the initial one.

The nitrogen, which was supplied by the British Oxygen Co., compressed in a steel cylinder, turned out to be very nearly pure; it is separated from liquefied air, and is certainly more pure than hydrogen as supplied in cylinders, and gives better results. The spheres are made of thick white glass, and are tested to about four times the load they are worked under. The spark ball is advanced by means of a fine screw forty-eight threads to the inch, cut on ¼-inch rod, working in a boss which forms a part of the gun-metal cap with which the glass globe is closed. If the screw is carefully fitted by Whitworth screwing apparatus, no gland or stuffing-box is required. The screw is slightly lubricated with a mixture of equal parts of pure india-rubber and vaseline. The length of the spark is measured by means of a divided head attached to the screw.

It might be supposed that a long spark in air at normal pressure would have the same effect as a spark shortened by gas pressure; but experimental evidence shows that the thick, steady, well-formed spark made under pressure gives far the most trustworthy results. Sparks made in air at normal pressure often do not strike from the nearest surfaces, but strike along an arched path, this effect reducing the discharge and rendering it variable in its intensity; but when the high-presseure nitrogen spark-gap is employed, the discharge from the Tesla apparatus is steady and unvarying during periods of time such as forty or sixty minutes. F. J. JERVIS-SMITH.

The Small Motion at the Nodes of a Vibrating String.

IT is generally recognised that the nodes of a string which is maintained permanently in oscillation in two or more loops cannot be points of absolute rest, as the energy requisite for the maintenance of the vibrations is transmitted through these points. I have not, however, seen anywhere a discussion or experimental demonstration of some peculiar properties of this small motion. A brief note may therefore be of interest.

In the first place, the small motion at the node is in a phase which is different from that of the rest of the string. The exact difference of phase is shown by a dynamical investigation to be a quarter of an oscillation. The motion is of very small amplitude, and it might therefore be thought a difficult matter to verify this experimentally. I have, however, devised some convenient arrangements with which this can be effected. I shall here mention only one method: this was to compound the oscillation at every point on the string with another perpendicular to it of half the frequency, and to observe the compound oscillation at the nodes and elsewhere.

Such a compound oscillation can easily be maintained permanently by having the string attached to the prong of an electrically maintained tuning-fork, so that it lies in a plane perpendicular to the prongs, but in a direction inclined to the line of their vibration. When the load on the string is slightly greater than that necessary for the most vigorous maintenance, points on the string describe parabolic arcs with concavities in opposite directions in alternate loops, the whole forming a beautiful and interesting type of stationary vibration. This is not, however, the stage convenient for observing the small motion at the nodes. When the tension of the string is relaxed, so as to make its vibration stronger, points on the string, *i.e.* except the node, describe 8 curves. The curve described by the node is neither a straight line nor an 8 curve, but is a very flat parabola. From this, the phase-relation between the small motion at the nodes and the large motion elsewhere is obvious.

If the node has a small motion, then, strictly speaking, there is no node at all. There should, however, be points at which the positions of the string in opposite phases might be supposed to intersect. One might suppose that these points, or "fictitious nodes," should execute a very small, almost microscopic, movement. As a matter of fact, these "fictitious nodes." oscillate parallel to the string through a range equal to the whole length of a loop. This somewhat striking effect may be observed without difficulty by illuminating the string with periodic illumination of twice the frequency of the oscillation.

Post-Box 59 Rangoon. C. V. RAMAN.

An Instance of Prolonged Pupation.

THE following facts in connection with a specimen of the privet hawk-moth may possibly be of interest to some of your readers.

The caterpillar, which was reared from the egg at Tunbridge Wells, pupated between August 7 and 9, 1906, and the pupa was sent out to me by post. The moth did not emerge until October 16, 1908, having been more than two years in the pupal state. Being the only specimen I have, I cannot say whether it shows any variations; but it is not stunted, measuring just over 4 inches across the expanded wings. GEO. H. WYLD.

Sydney, N.S.W.

A SCIENTIFIC MISSION IN ETHIOPIA.[1]

ABYSSINIA—and even in a more general way the whole Empire of Ethiopia—though it was the first portion of tropical Africa to come within what one might term the scientific cognisance of the civilised world, the world of Mediterranean Europe and Western Asia, remains, nevertheless, to this day the least understood and one of the most imperfectly explored parts of Africa. In all probability, more is known about the fauna, the flora, the human races, and languages of even the most recently revealed recesses of the Congo Basin, of the Central Sudan, the Liberian hinterland, and the south-western part of the Niger Basin (to mention some of the least-known parts of tropical Africa) than is recorded of the dominions of the Emperor Menelik.

This ignorance of Ethiopia (from the point of view of modern science) is, of course, proportionately estimated in relation to the extraordinarily important position all this region occupies in the study of Africa, in the solution of African enigmas. It is an area of about 200,000 square miles, containing exceptionally high mountains, the tops of which, but for the increasing aridity of North-East Africa, should be even more covered with glaciers than is the case with Ruwenzori, under the Equator, for the Ruwenzori range only exceeds in altitude by a few hundred feet the estimates of the highest points of northern and south-western Abyssinia. In Abyssinia alone, of all parts of tropical or Trans-Saharan Africa, may distinct evidences be found of the existence (on the high mountains and even in the plains) of a Eurasian fauna and flora—wild swine of the genus Sus, wild goats, wild dogs (*Canis simiensis*), and a few other beasts

1 "Mission en Éthiopie (1901–3)." By Jean Duchesne-Fournet and others. Tome i., pp. xviii+440; Tome ii., pp. xv+388, and atlas. (Paris: Masson et Cie., 1909.)

and a number of birds, trees, and plants, which in their affinities belong more truly to the Palæarctic and subtropical regions of Europe and Asia than to true Africa. There are also indigenous non-Negro races, like the Gala, which, by skull formation, by their use of the plough (absolutely unknown elsewhere in Negro Africa), by their languages, and many other points, are Asiatic rather than African.

Yet there are indications that Abyssinia, like Somaliland, Egypt, Mauretania, has been inhabited by man from a most remote period. Abyssinia may have been the first great focus of *Homo sapiens* on the African continent, to the south of the Sahara Desert; the region from which radiated Pygmies, Bushmen, Nilotic Negroes, Forest Negroes, and Bantu; Hamite, Egyptian, and the widespread negroid types typified by the modern Fula, Hima, Nyam-nyam, and Tibbu. Here took refuge an ancient offshoot of the Jewish people; here first of all with the armies of Ptolemy, was carried Greek civilisation into tropical Africa; hither came Persians after they had conquered southern Arabia; even more anciently than Jew or Persian a branch of the Semitic peoples was implanted in Abyssinia, which has left behind to this day at least two distinct language-groups of the Semitic family—Amharic and Harrari—in addition to the much later Arabic.

Here we are in one of the few portions of tropical Africa known to the Romans and to the civilised kingdoms of India before the time of Christ. (*Habshi*—derived from *Habesh*, an old Semitic name for Abyssinia—is even at the present day the common word for *negro* throughout Hindustan, and is also equivalent to "magician," because in the ancient lore of India, Abyssinians were identified with all the unholiest forms of magic. They are the "black magicians" of the "Arabian Nights'" stories. When the present writer first imported Sikh soldiers into Central Africa to fight the Arab slave traders, brave as they were in the presence of Arabs, they were at first frightened of the friendly negroes. "He is a Habshi, and will turn me into a rabbit," said one stalwart Sikh soldier to me when I asked him to travel alone through the bush with a negro guide.)

The Portuguese soldiers and missionaries first revealed some marvels of Abyssinia and Ethiopia to the modern European world of the later Renaissance. The Portuguese also, by splendid feats of arms, saved Christian Abyssinia from being conquered and effaced by a great army of Arabised Somalis under Muhammad Granye. Then came an interval of Abyssinian distrust of the greedy white man, and the attempts of Louis XIV. to supplant the Portuguese and frenchify Abyssinia in the seventeenth and eighteenth centuries led finally to great disasters, though it increased the acquaintance of the European world with these profoundly interesting countries. After that came the awakening of British interest through the travels of Bruce and Salt. The last named (Henry Salt) added considerably to our knowledge of the peculiar fauna of these countries.

During the first half of the nineteenth century, French interest in Abyssinia had a notable revival, and to the brothers D'Abbadie (of French-Irish origin) we owe much of our meagre knowledge of the Hamitic and negroid dialects of western Abyssinia and south-west Ethiopia. After this came British big-game hunters, consuls, and, finally, an army of British and Indian soldiers. Mr. W. T. Blandford, amongst other notabilities in zoology and geography, accompanied this expedition, and again revealed further remarkable features in the mammalian fauna of this peculiar part of Africa.

We have learnt a little more since from British and Italian missionaries and explorers (notably, as to fauna, from Major Powell Cotton), but more still from French expeditions, important among which have been those of the late Baron Carlos d'Erlanger and Baron Maurice de Rothschild.

One of the most remarkable French expeditions (not forgetting the work of Borelli some sixteen years ago) lately undertaken for the examination of Abyssinia and Ethiopia, is that which is the motive and the source of the present notice.

In a rather too intimate and emotional preface to this work, addressed to the father of Jean Duchesne-Fournet, we are told that this young and brilliant French explorer died in 1904, after his return from Abyssinia. In the course of his journeys he had reached the Wallaga country during the rainy season, and had suffered to a terrible extent from fevers, the sequelæ of which caused his death after his return to France. He was, in fact, a martyr to science, for the Wallaga country is a very little known part of East-Central Africa, lying to the south of the Blue Nile and of the Didessa River, and at no great distance from the frontier of the Egyptian Sudan.

The special object of Duchesne-Fournet's exploration of Wallaga was its reputation, not only as a possible source of future wealth in gold, but as a region from which gold was obtained in the distant past for the ancient Egyptians. Apparently a concession had been granted in that region to a French syndicate, and an active exploration was being carried on by a French engineer, Monsieur Comboul (who afterwards died). The Wallaga country has a mean elevation (averaging the French and Italian calculations) of about 6000 feet. It seems to have been visited by Jean Duchesne-Fournet alone (with an Algerian escort), or, at least, without any one of the French men of science on his staff, consequently, from the point of view of science, his incursion into this south-westernmost portion of the Emperor Menelik's dominions had little results of importance. He describes this country as "ravissant surtout avec sa belle verdure." It has a certain amount of woodland, rare elsewhere in the Abyssinian Empire. The rainfall is extremely heavy, and the country to a great extent lies within the basin of the River Didessa, an important southern affluent of the Blue Nile. It is covered with a luxuriant vegetation, and, where there is any agriculture (the land is inhabited sparsely by Galas and Walamo negroids), wheat, barley, maize, sorghum, beans, peas, potatoes, coffee, limes, bananas, and cotton are cultivated. The engineer Comboul seems to have found deposits of lignite, the importance of which was appreciated by the Emperor Menelik. But although in beauty this region was a paradise, and in products one of the richest parts in Africa, the climate seems to have been singularly unhealthy—constant fevers, not to be explained easily under the mosquito theory of infection, and terrible rheumatisms made its exploration during the rainy season almost a torture. Some of the great mountains (the summits of which would seem to reach here and there to 10,000 feet) contained immense caves, the exploration of which might yield important results in palæontology and palæanthropology.

The premature death of the leader of this expedition (the other members of which were Lieutenant Collat, Sergeant-Major Fontenaud, Louis Lahure—who afterwards greatly distinguished himself in explorations between the Benue and Lake Chad—H. Arsandaux, Dr. Goffin, and Dr. Moreau) to some extent spoilt the realisation of the full scientific results; as it is, the material collected and presented in the two volumes and the atlas of this book, give us, first of all, a most important *aperçu géologique* of the Danakil country, French Somaliland, and southern Abyssinia as far as Addis-Abeba, and a petrographical study of the same regions, with analyses of the rocks and minerals collected, and many photographs to show the types of landscape. These photographs are most conscientious, but the country presented to our eyes between Addis-Abeba and the Gulf of Aden is certainly one of the least alluring of all Africa. The Sahara Desert is much more attractive from the painter's point of view.

Some beetles were collected and are described. There is a most important article (taking up a considerable proportion of the second volume) on the anthropology and ethnography of southern Abyssinia, by Dr. R. Verneau, of the Paris Museum of Ethnography. This is accompanied by admirable photographs of skulls, of clothing and adornments, of musical instruments, pottery, jewellery, and horse harness; but the photographs taken by the expedition of living human types are, with one or two exceptions, not good or trustworthy, since they have been too much touched up in order to make them presentable pictures, or else they are very minute. The author of this section (Verneau) would seem to have arrived at the following general conclusions:—That in the portions of Abyssinia and northern Ethiopia in which the Duchesne-Fournet expedition collected skulls and took careful measurements of the living body, there were, besides the pure-blooded Negro, three distinct human types:—(1) The *Amhara* or *Abyssinian* (with which might also be grouped the *Gala*; (2) the *nigritised Abyssinian* (simply the result of ancient and modern intermixture between the Hamite—Abyssinian, Gala—and the Negro); and (3) a most interesting form, the *Berber* (this is a short title for the descriptive term given by Dr. Verneau, who calls it, "Type Abyssin clair, à cheveux lisses ou ondulés," and elsewhere, "Berbère"). This "third ethnic element" he describes as "very different from those which I have already set apart." It is one which has made its influence felt in Abyssinia, but, like the Negro element, it has crossed with the Hamite or Ethiopian (type No. 1), and as the result of this mixture its characters have become sensibly attenuated. "Nevertheless, one may affirm that this type No. 3 is of a fair complexion, slightly *cuivré*, and is further notable because it has evidently lightened the complexion of the skin in 13·5 per cent. (approximately) of the actual population." "Type No. 3," he goes on to say, "has blue eyes, or must have had blue eyes originally; for one could scarcely derive the blue, grey, or green iris (which is that we have noted in the proportion of 11·7 per hundred amongst modern Abyssinians) from the Ethiopian or the Negro. It is also type No. 3 which has certainly introduced the smooth or very slightly undulating hair, which has been found in 13·2 per cent. of the individuals under examination. On the other hand, this light-skinned race has not introduced tall stature amongst the people, but rather lessened the stature of the Abyssinians as compared with that of the Hamite and negroid races farther south."

In this race, Dr. Verneau apparently sees a marked resemblance to the Kabail of Abyssinia. One of the skulls depicted seems to display affinities with the Cro-magnon race of Western Europe.

There is a most comprehensive bibliography of Ethiopia in this work under review, a work which whets one's appetite for a complete examination of Abyssinia.

H. H. JOHNSTON.

THE SYSTEMATIC MOTIONS OF THE STARS.[1]

A SYSTEMATIC character in the proper motions of stars was discovered by Herschel, and accounted for by the motion of the solar system in space. Herschel's conclusions were for a time disputed by Bessel, but were confirmed by Argelander, and have since been generally accepted. In the last quarter of a century many determinations of the direction of the solar motion have been made, but the results have not shown that accordance which might have been anticipated. Particularly noticeable are the different results obtained from the proper motions determined by Auwers of the stars observed by Bradley in 1750, and re-observed about 1860, according to the method employed. Applied to these stars, the mathematical methods of attacking the problem developed by Airy and Argelander place the solar apex, or point to which the sun is moving, in declination $+35^\circ$ or thereabouts, while Bessel's method places it at -5°. In 1895, Dr. Kobold directed attention to these discrepancies, which seem to point to an error in the fundamental hypothesis underlying these methods of determining the direction of the solar motion. These methods are based on the assumption that the "peculiar" motions of the stars are haphazard, and have no preference for any particular direction or directions in space.

As an outcome of prolonged study of the subject, Prof. Kapteyn announced, in 1905, at the meeting of the British Association in South Africa, that this hypothesis was untenable. He used the well-determined proper motions of 2400 stars extending from the pole to 30° south of the equator given in Auwers-Bradley. Dividing this area of the sky into twenty-eight regions, he determined the directions of the apparent proper motions of the stars in each region, and found that they showed a preference for *two* special directions and not for one only. When these favoured directions for the twenty-eight areas were plotted on a sphere, they were seen to converge to two points. Convergence to a point on the sphere indicates that the apparent linear motions of the stars are parallel, just as the radiant point of a meteor stream indicates the direction in which the meteors are all apparently travelling. Relatively to the sun, therefore, the stars are moving in two streams, inclined at a considerable angle to one another; these motions are apparent only, and, when the solar motion is subtracted, are resolvable into two streams moving in diametrically opposite directions, relatively to the centre of gravity of the stars. Kapteyn showed that the stars were equally distributed among the two streams, and that their relative motion was in a line in the plane of the Milky Way, directed towards the star ξ Orionis (R.A. 91°, decl. $+13^\circ$) and the opposite direction. The apparent motions of the stars are thus resolvable into a combination of (1) a haphazard motion, (2) the reversed solar motion relative to the centre of gravity of the stars, and (3) the stream movement in the direction of ξ Orionis and the opposite direction. It was pointed out by Kapteyn that the determinations of the solar motion made by Airy's method, the one most generally adopted by astronomers on account of

[1] (1) J. C. Kapteyn, Reports of the British Association for the Advancement of Science, 1905, p. 257.
(2) A. S. Eddington, Monthly Notices of the Royal Astronomical Society, 1906, vol. lxvii., p. 34, and vol. lxviii., pp. 104 and 588.
(3) K. Schwarzschild, Nachrichten von der Königlichen Gesellschaft der Wissenschaften zu Göttingen, 1907, p. 614, and February, 1908.
(4) S. Beljawsky, Astronomische Nachrichten, Band clxxix, p. 293.
(5) F. W. Dyson, Proceedings of the Royal Society of Edinburgh, 1908, vol. xxviii., part i., p. 231; 1909, vol. xxix., part iv., p. 376.

its simplicity and convenience, were not much in error, in spite of the systematic character of the motion of the stars in these two streams. For the equations which result from Airy's method agree closely with those of a valuable method of determining the solar motion due to Bravais, which does not assume the haphazard character of the peculiar motions of the stars. But an entirely new fact in stellar astronomy has been elicited in the discovery of the systematic movements towards and away from ξ Orionis.

Mr. Eddington introduced a precise mathematical definition in place of the somewhat nebulous phrase star-stream. A "drift of stars" is defined as a group of stars the velocities of which relative to some system of axes are quite haphazard. The velocity of the "drift" is the velocity of the system of axes, while the "peculiar" velocity of a star is its haphazard velocity relative to the system of axes. Haphazard is defined as a distribution of velocities, according to Maxwell's law for the molecules of a gas. Formulæ are then developed to give the distribution of the directions of proper motions in any small area of the sky which would arise from the projection on the face of the sky of a star drift with a given mean peculiar velocity and a "drift" velocity given in magnitude and direction. Mr. Eddington applied his method to the consideration of the proper motions in Groombridge's catalogue, recently determined at

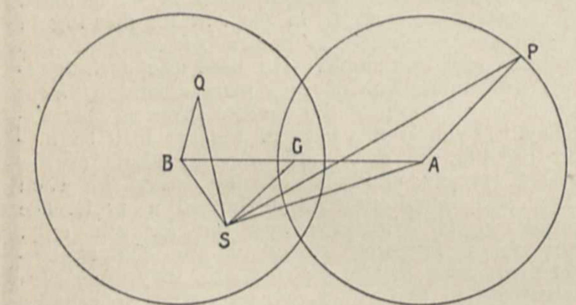


FIG. 1.—Velocity diagram according to Eddington's hypothesis.

Greenwich by Messrs. Dyson and Thackeray. The catalogue contains about 4500 stars within 52° of the North Pole, a large proportion being between magnitudes 7 and 9. Comparing the actual distribution with a theoretical one, based on the assumption that the stars form two drifts, he found close accordance. The stars were equally divided between two "drifts" the apparent directions of which were in good agreement with Kapteyn's results. The two streams did not show any distinctive features, each contained bright and faint stars, and stars of all types of spectrum, and, further, the mean distances from the sun of the stars contained in the two "drifts" were the same. Additional confirmation was obtained from 1200 stars within 10° of the North Pole, the proper motions of which had been determined by comparison of the Greenwich positions in 1900 with those found by Carrington in 1855. In a later paper, and by a somewhat different method, about 2000 fairly bright zodiacal stars were also examined.

According to Mr. Eddington's determination, the velocity of one stream relatively to the sun may be represented by SA, and that of the other by SB, while the haphazard velocities of the stars composing the streams are equally in all directions from the centres A and B, and their mean values are represented by the radii of the two spheres. The solar velocity relative to the centre of gravity of all the stars is represented by SG, and the rates at which the streams are separating by AB. If SP denote the velocity of one star relatively to the sun, this may be analysed into SA, the "drift" velocity, and AP, the "peculiar" velocity (which in this instance has its mean value); the drift velocity SA may be analysed into SG, the solar motion, and GA, the velocity of the stream. Similarly, SQ, the velocity of another star, may be resolved into a component of the second stream, the peculiar velocity of which is BQ, or only half the mean value.

Prof. Schwarzschild assumes that the "peculiar" motions of the stars do not obey Maxwell's law, but a slightly modified law in which the resolved parts of the velocities in one direction are all increased in a definite proportion, thus giving a spheroidal instead of a spherical distribution. When combined with the solar motion, this distribution of "peculiar" velocities gives two favoured directions for the proper motions of the stars included in any small area of the sky, and has the advantage of representing the stars as a single instead of a dual system. Applied to the Greenwich-Groombridge proper motions, the assumption shows a very satisfactory accordance with facts. According to Prof. Schwarzschild, the observed proper motions of these stars would be produced by a velocity of the solar system SG and "peculiar" velocities of

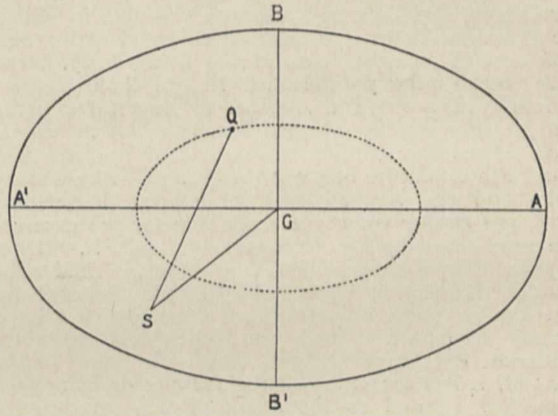


FIG. 2.—Velocity diagram according to Schwarzschild's hypothesis.

the stars the mean values of which in different directions are radii of the prolate spheroid ABA'B'. Thus the velocity SQ of a star is resolvable into SG, the solar motion, and GQ, the "peculiar" velocity. In this instance the "peculiar" velocity is one-half the mean "peculiar" velocity belonging to the direction GQ. In his second paper Prof. Schwarzschild develops his theory with great mathematical elegance so as to make it applicable to cases where the number of stars per unit area is small. In this form it is applied by Mr. Beljawsky to the stars of large proper motion in Prof. Porter's catalogues, although its application is not free from objection, as these stars were selected on account of their large proper motion, while the method is strictly only applicable to unselected proper motions.

Prof. Dyson collected all the proper motions greater than 20″ a century from various sources, and by a simple graphical method determined the favoured directions of motion. Partly owing to the small effect of accidental error of observation on the direction of the proper motion of these stars, and partly because only large proper motions were considered, the two apparent star streams were shown with great clearness. In the large majority of cases it was possible to assign individual stars to one or other of the two streams, and thus a verification was obtained of the result that the two streams showed no difference as regards the magnitude or type of spectrum of the stars in them. Of 1800 stars examined, 1100 belonged to the first stream, 600 to the second, and the remaining 100, which could not be assigned to either, showed no motion of a systematic character. The large proportion of stars belonging to the first stream arises from the mode of selection according to the magnitude of proper motion. Kapteyn's and Eddington's result, that when stars are taken without selection they are equally divided between the two streams, is used to determine the ratio of the stream velocities. When this is determined the apparent movement in two streams, as seen from the earth, is replaced by the solar motion and two streams moving in opposite directions relative to their centre of gravity.

There is at first sight considerable difference between Kapteyn's description (followed by Eddington and Dyson) of the systematic movements of the stars, and that of Schwarzschild. The dual character of Kapteyn's system should not be unduly emphasised. Division of the stars into two groups was incidental to the analysis employed, but the essential result is the increase of the peculiar velocities of stars towards one special direction and its opposite. It is this same feature, and not the spheroidal character of the distribution, which is the essential of Schwarzschild's representation. The results obtained by the two methods agree very closely. Defining the "apex" as the direction of the sun's motion relative to the centre of gravity of the stars, and the "vertex" as the direction of motion of one stream relatively to the other (Kapteyn) or the major axis of Schwarzschild's spheroid, the accordance of the different results is shown in the following table:—

	Apex R.A.	Apex Dec.	Vertex R.A.	Vertex Dec.
	°	°	°	°
Kapteyn—Bradley stars	—		91	+13
Eddington—Groombridge stars ...	266	+31	95	+ 3
Schwarzschild—Groombridge stars ...	266	+33	93	+ 6
Dyson—Stars of large proper motion.	281	+42	88	+24
Beljawsky—Porter's stars	281	+36	86	+24
Eddington—Zodiacal stars	—		109	+ 6

It may be noticed that the Groombridge stars gave almost identical results by the methods of Eddington and Schwarzschild, and that Beljawsky and Dyson, whose material was very similar, obtained results in close accord.

Although attention may be directed to Kapteyn's observation that the vertex lies in the plane of the Milky Way, it is too soon to offer any explanation of these remarkable movements of the stars. To have disentangled them from the irregular proper motions of the stars is itself a very important step. By clearing up the difficulty in the anomalous results previously found for the direction of the solar motion, and by the discovery of systematic movements in which all the stars share, Prof. Kapteyn has made the most important contribution to this branch of astronomy since the time of Herschel.

F. W. DYSON.

THE SEA OF ARAL.

RECENT explorations in Central Asia, and the evidence accumulating from many quarters of general desiccation of that area within historic times, give special interest and value to anything in the shape of observations of even approximate precision which point towards an opposite conclusion, or to a conclusion that variations in the amount of precipitation, where they occur, are more or less local and constitute merely a phase which, although it may be of relatively long period, does not represent continuous progressive change. The work carried on by L. S. Berg in the Sea of Aral between the years 1900–1906 form an important contribution to the subject of limnology generally, and more particularly to this question of desiccation. The original report on these investigations (Berg, "The Sea of Aral," St. Petersburg, 1908) is published in Russian, but students unfamiliar with that tongue may acquaint themselves with the present state of knowledge concerning the whole region by means of an article by Prof. Woeikow, published in the April number of *Petermann's Mitteilungen*. Prof. Woeikow deals primarily with Berg's observations, and his maps are reproduced, but he uses information derived from other sources, for purposes of comparison.

The Sea of Aral is situated at an elevation of 50 metres above mean sea level, and its area of 63,270 square kilometres places it fourth in size amongst the inland lakes of the world. The mean depth is 16 metres, and the maximum 68 metres, depths exceeding 30 metres occurring only in one small depression in the west and two still smaller ones in the north of the basin. The volume of water is computed to be 1012 cubic kilometres, only slightly greater than that of Lake Ladoga, which has about one-quarter of the superficial area, and about one-tenth of Lake Baikal, which is little more than half the size. The supply of water comes wholly from the two rivers Amu and Syr, which together deliver, on the average, some 1500 cubic metres per second. Most of the water is derived from the melting of mountain snows, the months of maximum flow being June, July, and August. Berg gives the mean salinity as 10·75 *pro mille:* compared with analyses made during the 'seventies of last century, which yielded an average of over 12 *pro mille,* this shows a marked freshening, due, as appears, to an increased volume of water.

The survey of the Sea of Aral by Admiral Butakow in the late 'forties formed the first foundation of accurate knowledge, and there is evidence to show that at the time of that survey the level of the water was relatively high. Few precise measurements were made for a long time afterwards, but it seems certain that after the 'forties a period of falling level began, and continued for some thirty to thirty-five years. Borczow reported diminishing area in 1857. The period 1859 to 1874 is blank, or nearly so. Sewertzow, Subow, and Kaulbars (1873–4) found great shrinkage on comparison with Butakow's survey, and further comparison with the records of Meyendorff and Ewersman (1820) seemed to justify the conclusion that a general desiccation of this part of Central Asia was taking place continuously. K. Schulz, surveying in the north-eastern end of the sea in 1880, found still further shrinkage since 1874.

From 1880 to 1899, when Berg first visited the region, another blank occurs; but in 1899 Berg found a rise of level in full progress, the height already attained exceeding not only that of 1874 and 1880, but that of Butakow's records in the 'forties. Islands, for example, which appeared in Butakow's map, and which had become peninsulas in the 'seventies and 'eighties, were submerged. Working from the levels of Tillo at Karatmak, Berg estimated a height of 1·21 metres in 1901 above that in 1874. Glukhowskoy found a fall of 71 centimetres between 1874 and 1880, giving a rise from 1880 to 1901 of about 2 metres, or 9 centimetres a year. The rise has continued, and Berg now gives it as 2·75 metres in 1903, and 3 metres in 1908. The depth of the lake being mostly shallow, this rise corresponds to a very considerable increase in area; the increment in volume of water between 1880 and 1908 is estimated at 20 per cent.

Other lakes to the north, north-east, and east of Aral show a similar rise during the last fifteen or twenty years. Lake Balkash has been rising since 1890; Lake Aschikul, in the Tschu depression, which was dry in 1888, was full in 1900, and there is a marked rise in many lakes in the Kirghiz Steppe, along the line of the West Siberian railway, and elsewhere.

The observations of rainfall taken at Barnaul on the upper Ob since 1838 are of great significance in this connection. The annual amount diminished from 1838 till 1868, then increased rapidly till 1895, and it has remained high, with small variations, since that year, the highest five year average (to end of 1906) being 1902–6.

The evidence goes then to show that the supposed continuous drying up of Central Asia has no existence in fact, but that variations occur which may or may not be periodic. If they are recurrent, the period must extend over at least sixty years, and its precise length cannot be determined before the end of the twentieth century, at the earliest.

Prof. Woeikow adds an interesting section on the history of the Sea of Aral, which has, naturally, important bearings on the question of secular variations of climate. A rise of the river Amu of only 4 metres above the level of 1901 would cause an overflow of part of its waters by the Usboï to the Caspian, one effect of which would be that the sea of Aral would become a fresh-water lake. Historical evidence (see Barthold, "Scientific Results of the Aral Expedition," 1902; and "Historical Geography of Iran," 1903: Berthold, by the way, is of opinion that the climate of Iran and Turan, so far as can be gathered from historical evidence, has remained practically unchanged for 2400 years) goes to show that from the thirteenth to the end of the sixteenth centuries this overflow actually occurred; and it would seem that this was a period of comparatively high rainfall in eastern Europe and western Asia.

A final section of Prof. Woeikow's paper deals with the thermal relations of water and air over the Sea of Aral. Space forbids a summary of the extremely interesting results obtained from Berg's observations, which appeal, perhaps, more to the specialist.

The definite conclusions set forth by so high an authority as Prof. Woeikow are of profound significance. The variations in the breadth of the grass belts between forest and hot desert, whether "savana" or "steppe," afford some of the most complex problems awaiting the geographer; the variation is probably greater the greater the total width of the belt, and the area in which the rainfall oscillates above or below a *minimum* point determining the possibility of human settlement of one kind or another is probably also greater. If it can be established that there is in effect no real evidence to show that in Central Asia a continuous diminution of rainfall is going on, but that a period of 30 or 40 years, or even of 300 years, of relatively small rainfall has passed its minimum, and that a similar period of greater fall has begun, then it follows that the historical problem of the depopulation of many of those regions, a problem of which the question of water supply can form only one element, becomes greatly modified. A thirty years' drought is no doubt sufficient to depopulate any district which has a low rainfall at the best of times, but increased rainfall does not necessarily mean immediate repopulation; and it does not follow that a region which has been deserted by its population at one time, through drought or other cause, has remained uninhabitable ever since. Again, it may be that large areas which for fifty years or more have been regarded as beyond hope will before long yield to modern methods of development and be added for a generation to come to the wheat producing, or at least the "ranching" regions of the world.

It is well that a belief which has often, in the absence of direct evidence, been used to bolster up the conclusion that rainfall was also diminishing a long way from Central Asia (the writer has heard it seriously used to support the contention that diminished yield of wells sunk in the chalk of south-eastern England was due to secular change of climate) should be definitely disposed of irrespective of its irrelevance. Assuming that no case of constant progressive diminution of rainfall in any part of the world has been established, and that none is now likely to be established, the problem seems to be to ascertain the nature and duration of these variations extending over long intervals of time. Are they periodic? if so, what is the length of period? What is the current phase at different parts of the earth's surface, and to what is the difference due? Central Asia has apparently just passed a *minimum* phase—has Central Africa just passed a maximum? Apparently fifty years of observation will be required to settle these questions.

H. N. D.

NOTES.

SIR JOSEPH LARMOR, Prof. Felix Klein, and Prof. H. Poincaré have been elected honorary members of the Calcutta Mathematical Society.

THE new rooms of the Royal Society of Edinburgh will be inaugurated on Monday next, November 8, when Sir William Turner, K.C.B., F.R.S., president of the society, will deliver an address, and a reception will be held.

PROF. K. SCHWARZSCHILD, director of the Göttingen Observatory, has been appointed to the directorship of the Royal Astrophysical Institute of Potsdam, rendered vacant by the death of Prof. Vogel. His position at Göttingen is to be filled by Dr. J. Hartmann, hitherto an assistant at the Potsdam institution.

THE first fellowship established under the will of the late Dr. Sorby, F.R.S., of Sheffield, as reported in our issue of July 8 (vol. lxxxi., p. 42), has been awarded by the joint committee nominated by the Royal Society and the University of Sheffield to Dr. Jocelyn F. Thorpe, F.R.S., who will engage upon a research on the chemistry of the imino-compounds.

A REUTER message from New York states that Mr. J. D. Rockefeller has made a donation of 200,000*l.* in support of a commission of eminent medical men to investigate the hook-worm disease, which is prevalent in the rural districts of the southern States.

A MEETING to inaugurate the new observatory and meteorological station of the Hampstead Scientific Society will be held on Saturday, November 6, at 3.30 p.m., at Heath Mount School, Heath Street, Hampstead. Mr. P. E. Vizard will take the chair, and the speakers will be Dr. F. Womack and Dr. H. R. Mill.

THE eighty-fourth Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Mr. W. Duddell, F.R.S., his subject being "Modern Electricity." The course, which will be experimentally illustrated, will commence on Tuesday, December 28, and will be continued on December 30, 1909, January 1, 4, 6, and 8, 1910.

At the opening meeting of the Institution of Electrical Engineers on November 11, a marble bust, by Hamo Thornycroft, of the late Dr. John Hopkinson, F.R.S., who was president in 1890 and in 1896, will be presented to the institution by Prof. Bertram Hopkinson on behalf of his mother, Mrs. John Hopkinson.

A departmental committee has been appointed by the Home Secretary to inquire into the working of the existing special rules for the use of electricity in mines, and to consider whether any, and, if so, what, amendments are required. The members of the committee are:—Mr. R. A. S. Redmayne (chairman), Mr. C. H. Merz, and Mr. R. Nelson. Correspondence may be addressed to Mr. Nelson at the Home Office.

Preliminary particulars have been sent to us of the United Provinces Agricultural and Industrial Exhibition which is to be held in Allahabad in December, 1910. An agricultural court will form one of the main features of the exhibition, and will be arranged on a scale more extensive than anything previously attempted in India. The Agricultural Department of the United Provinces has assumed responsibility for the agricultural court, and inquiries regarding it should be directed to the Deputy Director of Agriculture, Cawnpore. It is hoped that this court will contain an economic collection of agricultural exhibits of interest, not only to the producer, but also to the consumer and to the manufacturer of finished articles from raw products.

Science in the daily Press usually consists of snippets of sensational information which if true is not new, and if new is not true. Any attempt to represent the true position of scientific work and thought, the progress of research, and the best aims of higher education for the enlightenment of the general public is worthy of encouragement. We are glad to see, therefore, that the *Standard* has decided to pursue the policy of presenting its readers with systematic surveys of scientific research and progress by means of special articles, reports of the proceedings of learned societies, and in other ways. An article upon the place of research in education was contributed by Principal Miers, F.R.S., to Monday's issue (November 1), and Sir Joseph Thomson will discuss the research degree and its working at Cambridge in an article which will appear on the first Monday in December. Particular attention is to be given to research facilities and results, and the intention of the scheme is to make the public realise what the scientific spirit signifies and what is being done by it for the advancement of natural knowledge. Such efforts to direct public attention to the aims, methods, and conclusions of science should lead to increased recognition of the national value of research and higher education. We shall watch the experiment with interest, and in the hope that it will meet with unqualified success.

October was a wet month in nearly all parts of the British Isles, but the excess of rain was due to the remarkable falls which occurred during the closing week, when the south and east of England, especially, came under the influence of a cyclonic disturbance which, for a time, remained fairly stationary over the entrance of the English Channel. The weather report for the week ending October 30, just published by the Meteorological Office, shows that at Broadstairs the total for the period was 6·03 inches, and in three days the rain yielded 5·79 inches; at Margate the total for the week was 5·68 inches, and at Brighton 5·15 inches. On one day in the middle of the week the rainfall at Brighton measured 3·32 inches, at Broadstairs 2·93 inches, at Margate 2·73 inches, and at Shoeburyness 2·50 inches. Some remarkable falls have undoubtedly occurred, but it is rather too early for an exact statement of facts. The aggregate rainfall for the month is reported as 9·82 inches at Shanklin, 9·40 inches at Southampton, and more than 8 inches at Brighton and Bournemouth. At Valencia the total rainfall for October is 8·06 inches, and rain fell every day with three exceptions; at Jersey the total was 7·14 inches. At Greenwich the aggregate measurement for the month is 4·07 inches, whilst the average for October during the last half-century is 2·78 inches, and rain fell on twenty-two days. In 1880 the October rainfall at Greenwich was double the measurement for last month. At several places in Scotland and in the north of England the rainfall for October was slightly less than the average. The month was unusually mild, and the duration of bright sunshine varied considerably in different parts of the country.

In his presidential address to the Institution of Civil Engineers on Tuesday, November 2, Mr. J. C. Inglis did not deal with any particular engineering subject, but rather commented upon the recent activities of the institution, the professional status of the engineer, and the position he occupies in relation to certain economic questions of the day. Referring to the new by-laws and regulations drawn up with the object of securing a higher and more efficient standard of training than has hitherto been required, Mr. Inglis pointed out that there still appears to linger a certain popular confusion of ideas regarding knowledge which can be tested by question and answer in ordinary examination papers, and ability to apply such knowledge intelligently to the practical problems of every-day professional life. The Institution of Civil Engineers, differing perhaps in degree, though not, it is thought, in principle, from the views sometimes entertained by other bodies on this subject, has persevered throughout in the belief that for success in the application of the great powers of nature to the use and convenience of man, there can be, as a rule, no efficient substitute for regular training under those who are practising that art; albeit, the foundation of intelligent work in this direction lies in the possession of sound education and appropriate scientific knowledge. The successful engineer of the future must possess in an increasing degree a thorough knowledge of the principles of design, of the materials to be used, and their behaviour when in use (keeping in view the facility and cost of repairs), and of the actual working conditions affecting the life of the structure or plant or machine designed. The engineer should not only know how to design his works, but be familiar with the conditions under which they are to be used. The practical engineer of the early part of the nineteenth century built up his theory from his personal experience, and applied his self-taught theories according to his judgment. The practical engineer of the twentieth century is he who, knowing the theoretical principles of his profession, employs as data the facts gathered from his experience, and whose generalisations from such experience merely consolidate his knowledge of principles.

Naturen for October contains an appreciative memoir by Mr. P. R. Sollied, accompanied by a portrait, of Emil Christian Hansen (1842–1909), with an account of his bacteriological researches.

We have received a specimen copy of the first part of "Coleopterum Catalogus," edited by Mr. S. Schenkling, and published by W. Junk, of Berlin, this part being the work of Mr. R. Gestro, and dealing with the family Rhysodidæ. Full synonymy of the families, genera, and species is given, but there are no diagnoses. An index of the species of this family is given at the end of the part.

To the October number of the *Zoologist* Mr. A. H. Patterson communicates the first part of an interesting account of the fisheries and fish of east Suffolk, with special reference to the takes of herring and mackerel at Lowestoft. In regard to the apparently capricious movements of the shoals of mackerel, the author expresses the opinion that these are entirely due to tidal and other influences affecting the natural economy of the species.

In their report for the year ending June 30, the members of the committee of the Manchester Museum put on record their regret at the resignation of Dr. W. E. Hoyle, who held the office of keeper (a title latterly changed to director) of the establishment for the long period of twenty years. Dr. Hoyle resigned on March 25, when he was appointed director of the National Museum at Cardiff. Among important additions to the museum during the year under review, reference may be made to a collection of fossil fishes made by the late Mr. John Ward.

According to the *Museum News*, the authorities of the Children's Museum at Bedford Park, Brooklyn, have been devoting their attention during the past summer to exhibits illustrative of the Hudson-Fulton celebration. A large series of the animals inhabiting the country at the time of Hudson's visit has been placed on exhibition, with special notes to those which are now on the point of disappearing or which have been already exterminated. Such species of trees growing in the museum gardens as were native to the country in Hudson's time have also been marked with special labels.

It is satisfactory to learn from the September number of the *Victorian Naturalist* that the colony of sea-lions on "Seal Rocks," in Bass Strait, continues to flourish under Government protection. In November, 1908, a party of naturalists left Melbourne for a cruise in Bass Strait, and one of their number gives the following account of their visit to the sea-lions:—"As we approached this haunt of the seals, hundreds of the animals could be seen in the water, and from the rocks came, borne on the wind, the sound of their voices. The rookery presented a 'moving spectacle,' as we surveyed it through binoculars from the steamer's deck. Huge brown forms were clambering among the pools and darting in and out of the surf, while sleek cubs lay basking in the sunlight beside their anxious mothers." In the same issue attention is directed to the serious destruction now being inflicted on the native bird-fauna of the country by the progeny of introduced European foxes.

In vol. cxviii., part i., of the *Sitzungsberichte der k. Academie der Wissenschaften*, Prof. O. Abel gives a restoration of the skeleton of *Eurhinodelphis cocheteuxi*, of the Belgian Upper Miocene, in which the prolongation of the toothless rostrum far in advance of the lower jaw is well shown. The length of the figured skeleton, which is probably that of a male, is nearly 16 feet, but the majority of specimens are smaller. From the strong development of the caudal vertebræ, indicative of powerful tail-muscles, the author infers that these cetaceans were swift swimmers, while the free cervical vertebræ permitted, as in the fresh-water Iniidæ and Platanistidæ, of considerable movements of the head. These circumstances, taken in connection with the long edentulous rostrum, projecting far in advance of the lower jaw, and the weak state of the dentition generally, suggest that these long-snouted dolphins swam on the surface of the sea, where they captured their food—probably fishes—in much the same manner as does the skimmer (Rhynchops) among birds. Dr. Abel also describes the skull of *Saurodelphis argentinus* from the Argentine Pliocene, and shows that the genus was nearly allied to the existing Amazonian Inia.

The brain of the late Prof. D. J. Mendeléeff, the chemist, has been investigated and described by Profs. W. von Bechterew and R. Weinberg. The results of their investigation, with eight finely finished plates, form the first of a series of monographs dealing with the anatomy and development of the body, which is to be edited by Prof. Wilhelm Roux, of Halle, and published by Mr. W. Engelmann, of Leipzig. The size of the great chemist's brain was above the average, but not remarkably so; its weight was 1571 grams. The convolutions are simple in their arrangement; indeed, no one, from a mere examination of the organ, could have formed any opinion—at least in our present state of knowledge—as to the very special qualities manifested by it in life. Only two features were in any degree peculiar—a highly convoluted part of the left parietal lobe and a comparatively small and simple temporal lobe. Profs. Bechterew and Weinberg have made a very welcome addition to the limited number of descriptions of the genius-brain, and if at present the results of their labour appear to be negative, the day may soon come that will provide a key to the facts which they have been content merely to tabulate and to describe accurately.

Prof. E. Gaupp, of Freiburg, has devoted the fourth part of the "Sammlung anatomischer und physiologischer Vorträge und Aufsätze" to the consideration of the asymmetry of the human body (Jena: Gustav Fischer). From a consideration of the literature dealing with this matter, he has come to the conclusion that asymmetry in the right and left halves of the body is normal, and is to be regarded, not as a defect, which was the opinion formulated by Bichat a century ago, but as an advance and sign of specialisation. The asymmetry of the skull, face, jaws, spine, chest, pelvis, and limbs is not present at birth; it appears as the individual becomes adapted to his surroundings. The asymmetry is not a question altogether of right- or left-handedness or right- or left-brainedness; in Prof. Gaupp's opinion the tendency to a right- and left-sided specialisation is inborn in the individual. The asymmetry is simply exaggerated by the reaction of use and disuse. Classical sculptors represented in their work a degree of asymmetry of the face equal to that seen in modern races. The greater the degree of asymmetry the higher the point of evolution. Prof. Elliot Smith found that the hemispheres of the negro brain, and especially those of the anthropoids, showed a smaller degree of asymmetry than those of European races.

An article by Mr. B. L. Issatchenko, continuing two earlier communications on the conditions for chlorophyll formation, is published in the *Bulletin du Jardin Impérial Botanique*, St. Petersburg (vol. ix., part v.). The author states that a low temperature (−8° C.) does not prevent the formation of chlorophyll, and that it is formed in plants as quickly at a low temperature as a high one, the formation of the pigment depending exclusively on the strength and duration of the light. According to other results obtained, the formation of chlorophyll continues in the presence of the vapour of formaldehyde or chloroform.

Dr. F. Krasser has prepared for publication a series of diagnoses, left by the palæontologist Stur, of some fossil plants found in Triassic beds at Lunz, in Lower Austria, that are assigned to the filicinean family Marattiaceæ. Seven genera and seventeen species are confirmed by Dr. Krasser, of which one genus, Speirocarpus, and ten species are new to science. Five of the genera go back to the Palæozoic, but Speirocarpus and Bernoullia have only been found in Mesozoic strata. The article appears in the *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften*, Vienna (vol. cxviii., part i.).

FURTHER information regarding the curious herbaceous Ecanda rubber plant, *Raphionacme utilis*, is published in the *Kew Bulletin* (No. 8). The plant grows abundantly on a plateau in the district of Bihé, Portuguese West Africa; it produces a short leafy shoot and a good-sized tuber, from which the rubber is obtained. The tubers vary in weight up to 5 lb., and occasionally exceed this measure. It seems probable that there may be more than one species. The plants can be propagated from seed, but take several years to reach a marketable size. In the same number of the Bulletin there appears a short note, by Mr. J. M. Hillier, with reference to a new rubber plant, *Asclepias stellifera*. The identification refers to samples of root rubber forwarded by Mr. J. Burtt Davy from the Transvaal, one of which was reported to be of good quality.

A FACT of peculiar interest in connection with plant distribution is presented by Dr. Engler in the discovery, announced in his *Botanische Jahrbücher* (vol. xliii., part iv.), of an African plant referred to the family Triuridaceæ. The plants of this family are saprophytes of such a reduced nature that there is some doubt whether they are correctly classed with monocotyledons. Several species, under two genera, have been discovered in tropical America and tropical Asia; also a new species from the Seychelles islands was described by Mr. Botting Hemsley in 1907. The latest species was collected in West Africa, in the Cameroons, so that the genus Sciaphila is now recorded from three continents. It is quite unlikely that the seeds of a plant which is a saprophytic inhabitant of virgin forest should be transported by water, and the problem of its existence in these distant isolated localities is exceedingly puzzling. An anatomical examination of the stem showed a reduced structure not inconsistent with a monocotyledonous position.

UNDER the subtitle "Les Districts littoraux et alluviaux," the Jardin botanique de l'État has issued, with the authority of the Belgian Ministère de l'Intérieur et de l'Agriculture, the first portion of a work on "Les Aspects de la Végétation en Belgique," by Profs. C. Bommer and J. Massart. The studies of these two authors in this field, the results of which have appeared in the pages of the *Bulletin de la Société royale de Botanique de Belgique*, are already well and favourably known. In a brief *résumé* Prof. Th. Durand, director of the Brussels Botanic Garden, explains the object the authors have in view, and informs us that the work, in its complete form, will include some 400 plates distributed in five parts, as follows:—i., Districts littoraux et alluviaux, by Prof. Massart; ii., Districts flandrien et campinien, by the same author; iii., Districts argilo-sablonneux et crétacé, by Prof. Bommer; iv., Districts calcaire et jurassique, by Prof. Massart; and v., District ardennais, by Prof. Bommer. The work will include in its scope the illustration both of the cultivated and of the uncultivated portions of Belgian territory, and will endeavour to give a complete picture of the vegetation of the whole country. The method adopted by the authors in preparing their illustrations has involved their securing photographs on plates measuring 30 cm. by 40 cm. With the object of rendering available for independent use the more important of these plates, it has been resolved to issue a reduced edition containing about one-fourth of the plates in the complete work. The copy of this reduced edition of the first volume, now under notice, contains twenty-four plates as against eighty-six plates in the complete edition of the same volume. These plates are excellent reproductions from photographs of great beauty. They largely explain themselves, and are highly instructive. The accompanying letterpress is reduced to a brief amplification, in three pages, of the systematic summary of the plates, whereof 1 and 2 illustrate the District des Estacades et Briselames; 3–9, the District des Dunes littorales; 10–13, the District des Alluvions marines; 14 and 15, the District des Alluvions fluviales; 16–22, the District des Polders argileux; while 23 and 24 illustrate the District des Polders sablonneux et des Dunes internes.

THE thirty-first and thirty-second reports of the Connecticut Agricultural Station for the years 1907–8 form a volume running into nearly a thousand pages. A considerable amount of space is devoted to the reports from the analytical laboratories, where large numbers of food-stuffs intended for human consumption are investigated in addition to the ordinary agricultural materials. In accordance with the American system, results of the analysis are published, together with the trade name of the article, the manufacturer, the dealer, the price, and the guaranteed composition, so that one can see at a glance which articles are above and which below their guarantees. Dr. Osborn, head of the laboratory for the study of proteids, reports that he has isolated a new substance from one of the wheat proteins, a di-peptide of proline and phenyl-alanine. This substance is important, not only in connection with the structure of wheat protein, but in connection with the chemistry of proteins in general. Quantitative determinations have also been made of the amounts of decomposition products of various vegetable proteins. The entomological department has spent much effort in subduing the gypsy moth at the only place in the State where it was found. The infected area was isolated by destroying the shrubs and bushes on all sides of it as far as possible; within the area all larvæ, pupæ, and egg-masses discovered were destroyed; 14,000 trees were banded and inspected daily. A new orchard pest, the peach saw-fly, which threatened great injury, was completely controlled by spraying with lead arsenate. In the agricultural department a number of experiments are recorded on the hybridisation of potatoes. The botanist records studies of the "calico" disease of potatoes, and chlorosis in other plants, the downy mildew of Connecticut, the root rot of tobacco caused by the fungus *Thielavia basicola*, and of certain heterœcious rusts of Connecticut having a peridermium for their œcial stage. The forester has carried out experiments on the economical planting of white pine, on different methods of seeding and planting forest trees, on the fertilisation of young trees by growing cow peas, on the progress of the white pine disease, and on methods of treating the pine weevil. The increased interest in forest planting in Connecticut is shown by the fact that about 100,000 forest trees were planted in 1906, 350,000 in 1907, and 600,000 in 1908. A forest survey is in hand, and a fire service has been organised.

PROF. L. DUPARC, assisted by Dr. Francis Pearce and Madame Tikanowitch, his colleagues in the University of Geneva, has issued the third and concluding part of his "Recherches géologiques et pétrographiques sur l'Oural du Nord; le Bassin de la haute Wichéra" (*Mémoires de la Société phys. et d'Hist. nat. de Genève*, vol. xxxvi., fascicule i., July, 1909, price 20 francs). The results of three expeditions, from 1904 onwards, are here reviewed, and the igneous and metamorphic rocks are described in considerable detail. The region lies on the west side of the Urals and north of Solikamsk, where numerous streams unite, flowing from a broad basin, to form the Vishera River, which in turn flows into the Kama, and thus into the Volga system. The plateaus, covered with stones and showing few good rock-exposures, represent a mass uplifted during the Hercynian earth-movements, and subjected to prolonged denudation. Interesting terrace-structures, preserved only among the hard quartzitic ranges, point to ancient epochs of erosion under conditions different from those of the present day. Successive terraces rising above one another, and apparently independent of tectonic structure, offer a problem which Prof. Duparc is compelled to leave at present unexplained. They certainly suggest, in the numerous sketches given, relics of abnormally large terraces of marine erosion rather than uplifted peneplains. Among the petrographic descriptions we note that a highly pleochroic amphibole, associated with magnetite, occurs in one of the ore-materials; the authors believe this to be a new species, and have elsewhere given it the name of "Tschernichéwite." Its characters are as yet incompletely determined; if we may judge from those here given, its weak birefringence seems to ally it to riebeckite, while its axial plane is in an unusual position for an amphibole, and its pleochroism is near that of glaucophane. The iron mines of the district are carefully described, and the memoir is well illustrated by photographic views and effective drawings of broad landscapes.

IN the *Reliquary* for October Mr. T. Sheppard, curator of the Municipal Museum, Hull, records the discovery at Malton, in Yorkshire, of two interesting bronze statuettes, one, the more primitive of the two, representing Hercules bearing the skin of the Nemean lion, the other Venus. They probably belong to the third century A.D., and may have been lost or buried at the time the Roman legionaries were withdrawn from Britain.

THE Meteorological Chart of the North Atlantic Ocean for November, issued by the Meteorological Committee, contains an account of a West India hurricane experienced by the ship *Barranca* (Captain W. Long) in August last. At noon on August 15 she was in 24° 42′ N., 57° 1′ W., with a falling barometer and strong easterly breeze. At 4 p.m. the barometer failed to respond to the diurnal range, which showed that a storm was not far distant. On the morning of August 16 the ship met the full force of the hurricane, and at 2h. p.m. the sea was "like a boiling cauldron." Next day the east wind veered to south-west, and the ship's position at noon was 22° 43′ N., 61° 44′ W., having apparently drifted some 100 miles to the north, out of her south-west course, in two days. Owing to careful navigation, in accordance with the rules laid down in the "Barometer Manual" issued by the Meteorological Office, the only damage sustained by the ship was a severe straining.

IN the *Rendiconti della R. Accademia dei Lincei* (vol. xviii., 1909) Dr. F. Eredia publishes an interesting preliminary note on the frequency of wind-direction in central Italy. The discussion shows clearly the different effects of the two slopes which divide the country from the Adriatic and Tyrrhenian Seas. Winds from N.–E. prevail along the Adriatic slope in summer and along the Tyrrhenian slope in winter, and winds from S.W.–N.W. predominate in winter along the Adriatic slope and in summer along the Tyrrhenian slope; thus, while one direction has its maximum of frequency on one slope, it has its minimum along the other. The author endeavours to explain these facts and to compare them with the theoretical laws of the circulation of the atmosphere.

A VALUABLE series of articles on life in the various colonies and other countries in which many of our young electrical engineers obtain posts has appeared in the *Electrical Review* during the last two months. Although intended, in the first instance, for electrical engineers, they will prove of great value to all who have thoughts of taking up appointments abroad, as they are in every case by men with practical experience of the countries about which they write. Each article deals with the climate of the country, the cost of living, the salaries, and the ultimate prospects of those taking up posts open to Europeans.

THE vacuum vessel introduced by Dewar has proved of such value as a means of improving the thermal insulation of bodies that it is no surprise to find it introduced into calorimetry. At the suggestion of Prof. Nernst, of the University of Berlin, Dr. H. Schottky has carried out a series of measurements with a modified form of Favre and Silbermann calorimeter, in which the mercury was replaced by pentane and the bulb of the calorimeter surrounded by a vacuum vessel. The instrument looks like a Bunsen ice calorimeter using pentane instead of ice, and having a vacuum vessel around its bulb. It has proved a great improvement on its predecessors, and is considered by Dr. Schottky to be extremely accurate. A full description appeared in the *Physikalische Zeitschrift* for September 15.

WE have received separate copies of a number of papers which have been written by the staff of the Physikalisch-technische Reichsanstalt, and have appeared in the *Annalen der Physik* and other periodicals during the past few months. Two of them deal with optical subjects, and are of special interest. In the first place, it has been found by Drs. E. Gehrcke and G. Leithauser that it is possible to convert a celluloid copy of a diffraction grating, such as have been made by Thorpe, of Manchester, for some time, into a reflecting grating by dusting it with kathode particles in a vacuum. The process gives gratings which are almost as good as the original. Further, Dr. L. Janicke has been investigating the properties of the spectral lines of the metallic elements by the high dispersion obtainable with the Lummer-Gehrcke plate spectroscope, and gives the wave-lengths of the sharp lines of the spectra of fourteen elements, which were used as the anodes of arcs burning *in vacuo*.

AT a recent meeting of the Association of Municipal and County Engineers a paper was read on the "G.B." tramway system and its results in Lincoln by Mr. S. Clegg, the city electrical engineer. The author stated that during the first twelve months a total of seventy-one live studs was recorded, these being mostly owing to defects in details in the original construction. The old type of cable had been completely replaced in 1908, and the average at present is about three live studs per month. Mr. Clegg considers that there is less danger to the public from shock and personal injury with the "G.B." system than with the overhead system. Studs which had become alive at Lincoln had always been located as soon as they occurred without danger to anyone.

COMMENTING on the aviation meetings at Doncaster and Blackpool, *Engineering* for October 22 directs attention to the advantages of the monoplane from the point of view of transport from place to place. The frame consists simply of the backbone carrying the engine, driving-seat, and controlling gear, together with the wheels on which the machine runs when on the ground. This can be sent complete in one piece, the main wings and the horizontal and vertical rudders being detached for the purpose. The wings are attached very easily by means of sockets on the backbone and by wire ties. In the case of one competitor, whose main wings had not arrived until late in the morning, these were all fixed up in about an hour. Probably with more experience it will be possible to design a monoplane which can be taken to pieces or erected complete in an hour or two. The biplane, having more numerous tie-rods, appears to require much larger packing cases or more time for its erection, according to the extent to which it is taken to pieces. In the air the biplanes certainly appear to be more steady than the monoplanes, the latter occasionally flying in a series of dips, especially when near the ground. When high up, however, the monoplane appeared very steady.

WHILE remarking on the enormous advance which has been made in aviation, *Engineering* points out that the motors have very far from the trustworthiness required for practical work, and each machine had several mechanics in attendance on it. The engines at present in use require a large amount of attention. This is a matter which should be capable of amendment. The other limitations which require attention are the incapacity for flying in bad weather and for alighting on rough ground. To be of any practical use, aëroplanes should be capable of alighting and starting from an ordinary grass or stubble field, and there does not seem the least difficulty in arranging for this; in fact, the combination of runners and wheels on the Farman machine would probably be satisfactory. Flying in a wind may possibly be largely a matter of practice and confidence, and it is quite possible that, with very little alteration in the machines, men will learn to fly in any reasonable weather.

Erratum. In the article upon the magnetic results of the *Carnegie* (October 28, p. 532, col. 2, line 3 from bottom) Dr. Bauer should have written ½° instead of ½′, which was the value given in the typewritten communication received from him and printed in NATURE.

OUR ASTRONOMICAL COLUMN.

CHANGES ON MARS.—Another large prominence on the terminator of Mars is announced by M. Jarry-Desloges in No. 4364 of the *Astronomische Nachrichten* (p. 335). This object was seen on the night of October 14–15 in the region of Phaëthontis, which itself was very white; this whiteness of Phaëthontis, and similar regions near the limb, was remarked by the Rev. T. E. R. Phillips in his observations of 1903.

A drawing of the planet, as it was seen by M. Antoniadi with an 83-cm. reflector on September 20, is published as a frontispiece to No. 10, vol. iii., of the *Rivista di Astronomia* (Turin).

HALLEY'S COMET.—In No. 4364 of the *Astronomische Nachrichten* (p. 333, October 20) Prof. Wolf publishes the position of Halley's comet as determined from a plate taken on October 10, and states that, with a power of 140 used on the reflector, he is able to see the comet as a small nebulous patch; but it is on the limit of visibility with this instrument, its magnitude being given as 14·5.

In the same journal (p. 335) Mr. Knox Shaw gives positions determined from photographs taken at the Helwan Observatory on September 13, 15, and 16 respectively.

An interesting popular article, dealing with the history and nature of the comet, appears in part cxliii. of *Chambers's Journal* (p. 710, November 1) from the pen of Dr. Alex. W. Roberts.

SUN-SPOT SPECTRA.—A summary of the results so far obtained from the study of the photographs of sun-spot spectra, taken at the Mount Wilson Observatory, is published by Prof. Adams in No. 2, vol. xxx., of the *Astrophysical Journal* (pp. 86–126, September).

The paper is too comprehensive for adequate summary in these columns, where many of the details have already appeared, but the various tables given will prove interesting and instructive to all workers in this branch of solar physics.

Prof. Adams believes that the intensification of various solar lines in the spot spectrum is due to the lowering of temperature, and not, in general, to a variation of pressure. Investigations at Mount Wilson, where a shift of 0·003 or 0·004 Å. could be detected, indicate that the excess of pressure in spots, over that on the surface of the sun, can hardly be so great as one atmosphere. A study of the enhanced lines, based mainly on the tables published by Lockyer, shows that of 144 such lines 130 are distinctly weakened, while fourteen show no change, in passing from the Fraunhoferic, to the spot, spectrum.

The lines of each element are studied *seriatim*, and of the lines of iron given by Rowland, 784, or 71 per cent., are affected in the spot spectrum; of the 558 lines due to iron alone, 300 are strengthened and 258 weakened in passing from the solar to the spot spectrum. The behaviour of the iron lines is best explained by the decrease of temperature in the spot.

The greater part of the unknown fluting, and band, lines in the spot spectrum may be accounted for by the presence of the titanium oxide, "magnesium hydride," and "calcium hydride" spectra, whilst the lines that are widened without marked increase of intensity are sufficiently explained by the existence of a magnetic field in sun-spots.

DESIGNATIONS OF NEWLY DISCOVERED VARIABLE STARS.—The committee for the A.G. Catalogue of Variable Stars publishes the permanent names of sixty-two recently discovered variables in No. 4364 of the *Astronomische Nachrichten.* The provisional name, permanent designation, position, and magnitude range are tabulated for each object, and a series of notes gives particulars of discovery and subsequent observations.

THE MOTIONS OF SOME STARS IN MESSIER 92 (HERCULES).—Prof. Barnard discusses the proper motions of certain stars in the cluster M. 92 in a paper appearing in No. 4363 of the *Astronomische Nachrichten.*

Micrometer observations of this cluster were made by Schultz, at Upsala, about 1873, and results were published for thirty-seven stars. These results, when compared with those obtained from a photograph taken in 1898, led Dr. Bohlin to the conclusion that some of the stars exhibited large proper motions during the twenty-five years' interval, but Prof. Barnard suggested that Schultz's observations of faint objects with a 9-inch telescope were probably not sufficiently exact to permit of this deduction; measurements of two photographs, taken with an interval of eight years between them, confirm the suggestion.

There are two stars, however, which show decided motions during the eight-year interval, one being No. 11 and the other a fainter star temporarily designated *a*. The former has an annual motion of 0·085″ in position angle 220° (8·5″ per century), and the second an annual motion of 0·065″ in position angle 181·4° (6·5″ per century). Prof. Barnard concludes that another fifty years should show motion in many of the stars of this cluster, whilst within a few hundred years it will be possible to investigate the laws which control the motions of this and similar great and crowded masses of stars. A carefully oriented reproduction of a photograph of M. 92, taken with the 40-inch telescope, accompanies the paper, and will facilitate further work on this interesting cluster.

SOLAR VORTICES AND MAGNETIC FIELDS.[1]

I HEARTILY appreciate the privilege of describing in this lecture-room some of the recent work of the Mount Wilson Solar Observatory. Like so much of the scientific research of the present day, it goes back for its origin to the fundamental investigations of English men of science. The spectroheliograph, which tells us of the existence of solar vortices, is a natural outcome of the application of the spectroscope in astronomy, where Englishmen were foremost among the pioneers. The detection of a magnetic field within these vortices followed directly from Zeeman's beautiful discovery of the influence of magnetism on radiation—a logical extension of the earlier work of Faraday—and from the classic investigations of Crookes and Thomson on the nature of electricity. In reviewing these great advances, investigators in other lands must again and again wonder at the exceptional ability of the English mind to make fundamental discoveries. When these discoveries have been made it is a comparatively simple matter to utilise them in many departments of science. Americans cannot fail to rejoice that they may share in the traditions of a race which counts among its members the men who have given the Royal Institution its fame.

It is customary to distinguish sharply between the observational and experimental sciences, including astronomy in the former. In physics or chemistry the investigator has the immense advantage of being able to control the conditions under which his observations are made. The astronomer, on the other hand, must be content to observe the phenomena presented to him by the heavenly bodies, and interpret them as best he may. I wish to emphasise the fact, however, that the distinction between these two methods of research is not so fundamental as it may at first sight appear. In 1860 a laboratory, in which experiments were conducted for the interpretation of astronomical observations, was established by Sir William Huggins on Upper Tulse Hill. The advantage of imitating celestial phenomena under laboratory conditions was thus appreciated half a century ago. I shall indicate later how important a part such a laboratory plays in the work of the Mount Wilson Solar Observatory. I shall also show that in other ways the astronomer may advantageously follow the physicist, particularly in the choice of observational methods and in the design of instruments of research.

Sun-spots were discovered as soon as Galileo and his contemporaries directed their little telescopes to the sun. In fact, ancient Chinese records indicate that spots of exceptional size had been detected by the naked eye many centuries before. Long after their discovery, the most diverse views were held as to the nature of sun-spots. Sir William Herschel mentioned the uncertainty which had existed prior to his time, remarking that the spots had been variously described as solid bodies revolving about the sun, very near its surface; the smoke of volcanoes; smoke floating on a liquid surface; clouds in the solar atmosphere; the summits of solar mountains, uncovered from time to time by the ebb and flow of a fiery liquid, &c. In Herschel's own view the spots are to be considered as the opaque body of the sun seen through openings in the luminous atmosphere which envelops it. Indeed, he considered that the sun should be regarded as the primary planet of our system, and even suggested the probability that it is inhabited. "Whatever fanciful poets might say, in making the Sun the abode of blessed spirits, or angry moralists devise, in pointing it out as a fit place for the punishment of the wicked, it does not appear that they had any other foundation for their assertions than mere opinion and vague surmise; but now I think myself authorised, *upon astronomical principles*, to propose the Sun as an inhabitable world, and am persuaded that the foregoing observations, with the conclusions I have drawn from them, are fully sufficient to answer every objection that may be made against it."[2]

Sir John Herschel did not abandon the idea of an opaque solar globe, but suggested that hurricanes or tornadoes might account for the piercing of the two strata of luminous matter which ordinarily conceal this globe. "Such processes cannot be unaccompanied by vorticose motions, which, left to themselves, die away by degrees and dissipate—with this peculiarity, that their lower portions come to rest more speedily than their upper, by reason of the greater resistance below, as well as the remoteness from the point of action, which lies in a higher region, so that their centre (as seen in our water-spouts, which are nothing but small tornadoes) appears to retreat upwards. Now, this agrees perfectly with that which is observed during the obliteration of the solar spots, which appear as if filled in by the collapse of their sides, the penumbra closing in upon the spot, and disappearing after it."

We now know that sun-spots are brighter than the brightest arc light, and that their apparent darkness is merely the result of the contrast with the intensely brilliant surface of the photosphere. We also know that the sun is a gaseous globe, attaining a temperature of about 6000° at its surface, and perhaps millions of degrees at its centre. If we examine a large-scale photograph of a sun-spot we see that it consists of a dark central region, called the umbra, and a surrounding area, decidedly less dark, called the penumbra. The structure of a spot, as this admirable photograph by Janssen shows, is granular, like that of the photosphere. In the penumbra these granulations seem to group themselves more or less radially, as though under the influence of some force directed toward or away from the umbra. Unfortunately, direct photographs of the sun have not yet attained such perfection as to show the most minute details of sun-spots. To appreciate these, we must have recourse to the exquisite drawings of Langley, the truthful quality of which is recognised by every astronomer who has observed sun-spots under favourable conditions. We shall see that the characteristic structure represented by these drawings is repeated, on a far greater scale, in the higher regions of the solar atmosphere disclosed on recent spectroheliograph plates.

Since the time of Sir John Herschel, many astronomers have proposed vortex theories of sun-spots. One of the first of these is the theory of Faye, who supposed the whirling motion to be the direct result of the peculiar law of the sun's rotation. This law was discovered by Carrington, who found from observations of spots near the equator that the sun completes a rotation in about twenty-five days, while the motion of spots at a latitude of 40° indicated the time of rotation to be nearly two days longer. Thus, as the rotation period increases toward the poles, the photosphere at the northern and southern boundaries of a sun-spot must move at different velocities (assuming the law of the sun's rotation to be the same as that of the spots). This difference in velocity would tend to set up whirling motions, clockwise in the southern hemisphere and counter-clockwise in the northern hemisphere. Sun-spots, in Faye's opinion, are the visible evidences of such whirls.

This theory has had many supporters, but it is now generally agreed that the difference in the rotational velocity of adjoining regions of the photosphere is not nearly sufficient to account for the observed phenomena. Secchi, one of the most assiduous observers of solar phenomena, was strongly opposed to Faye's theory. He pointed out that about 6 per cent. of the spots he observed gave some evidence of cyclonic action, but in the vast majority of cases such forms as Faye's theory seemed to demand were lacking. We nevertheless owe to Secchi a most striking drawing of a sun-spot vortex.

When the spectroheliograph was first systematically applied to solar research in 1892, many rival theories of sun-spots occupied the field. Since the function of this instrument is to photograph the phenomena of the invisible solar atmosphere, it might be hoped that the results would throw much light on the nature of sun-spots. For many years, however, this hope was not realised. The first monochromatic images of the sun were made with the K line of calcium. If we compare such an image with a direct photograph of the sun, made in the ordinary way, we see that the sun-spots are surrounded and frequently covered by vast clouds of luminous calcium vapour. These attain elevations of several thousand miles above the sun's surface, but they must not be confused with the prominences, which ascend to much higher elevations. When

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

[2] William Herschel, "On the Nature and Construction of the Sun and Fixed Stars," p. 20.

observed at the sun's limb, the bright calcium flocculi, as these luminous clouds are called, are so low, in comparison with the prominences, that they can hardly be detected as elevations. Thus our knowledge of the calcium flocculi must be derived mainly from the study of spectroheliograph plates, which show them in projection on the disc. I must not omit to mention, however, that the calcium vapour rises to the highest parts of the prominences, and that this higher and cooler vapour frequently indicates its presence on spectroheliograph plates in the phenomena of dark flocculi. These are relatively inconspicuous, however, and need not be discussed here.[1]

It soon appeared that the average photograph of bright calcium flocculi could not be counted upon to indicate the existence of definite streams or currents in the solar atmosphere. In 1903 the hydrogen flocculi were photographed for the first time. By comparing these flocculi with the corresponding calcium flocculi we see that, in general, dark regions on the hydrogen image agree approximately in form with bright regions on the calcium image. This might appear to indicate that hydrogen is absent in the regions where calcium is most abundant. An investigation of the question, however, does not lead to this conclusion. Dark hydrogen flocculi seem to mark those regions on the sun's disc where hydrogen is present as an absorbing medium, which reduces the intensity of the light coming through it from below. In certain areas, where the temperature is higher or the condition of radiation otherwise different, the hydrogen flocculi are bright. In many cases eruptions are in progress at these points, but in others the difference in brightness is apparently not the direct result of eruptive action.

The hydrogen flocculi, thus photographed with the lines Hβ, Hγ, or Hδ, differ in many respects from the calcium flocculi. Not only do they usually appear dark, where the calcium flocculi are bright: their forms exhibit striking peculiarities, which are absent or much less conspicuous in the case of calcium. The appearance of the calcium flocculi resembles that of floating cumulus clouds in our own atmosphere; their capricious changes in form reveal the operation of no simple law. But the hydrogen flocculi, on the contrary, exhibit a definiteness of structure in striking contrast to this appearance. Some of the photographs strongly remind us of the distribution of iron filings in a magnetic field, and suggest that some unknown force is in operation.

Such was the condition of the subject when the red Hα line of hydrogen was first applied to the photography of the flocculi, on Mount Wilson, in March, 1908. The calcium and hydrogen flocculi had been studied for several years, and much had been learned as to their nature and their motions. It had been found, for example, that the calcium flocculi observe the same law of rotation that governs the motions of sun-spots, while the hydrogen flocculi apparently follow a different law, in which the decrease in the angular rotational velocity from the equator toward the poles is much less marked. The latter result is in harmony with the investigations of Adams, whose accurate measures of the approach and recession of the hydrogen at the eastern and western limbs of the sun offer but little evidence of equatorial acceleration on the part of this gas. For this and other reasons it had been concluded that the hydrogen shown in such photographs reaches a higher level than the vapours of the bright (H_2) calcium flocculi. The region of the atmosphere previously explored with the spectroheliograph was nevertheless confined (except in the case of eruptions and dark calcium flocculi) to a comparatively low level, lying within a few thousand miles of the photosphere. What might be expected if a still higher region could be satisfactorily photographed in projection on the disc?

The red line of hydrogen offered the means of disclosing the phenomena of this higher atmosphere. As it may not immediately appear why different lines, caused by the radiation of the same gas, should not give precisely similar photographs, a brief reference to the aspect of a prominence in the red and blue hydrogen lines may be advantageous. Here are two photographs of the same prominence, seen in elevation at the sun's limb, one made with Hα, the other with Hδ. As the red line is very bright, even in the highest regions, the photograph taken with its aid shows the entire prominence. Hδ, on the other hand, is relatively weak at the higher levels, and consequently only the lower and brighter parts of the prominence are well recorded when this line is used. If, now, we suppose ourselves immediately above such a prominence, at a point where we observe it in projection against the disc, it is evident that the character of the hydrogen lines must depend upon their brightness at different levels. As we know that, speaking generally, absorption is proportional to radiation, the amount of light absorbed in the upper part of the prominence will be much greater for Hα than for Hδ. Hence the average level represented by the absorption of Hα will be higher than the average level represented by Hδ, since the higher gases play a more important part in the production of the former line. We may therefore expect that photographs of the sun's disc, taken with the light of Hα, will show the dark areas corresponding to absorption in the prominences much more clearly than photographs taken with Hδ. Moreover, since Hα is stronger than Hδ in the upper chromosphere, in regions where no prominences are present, the *average* level represented by this line will, in general, be higher than that represented by Hδ. A comparison of two photographs of the sun's disc, made with the lines in question, will suffice to make this clear. This

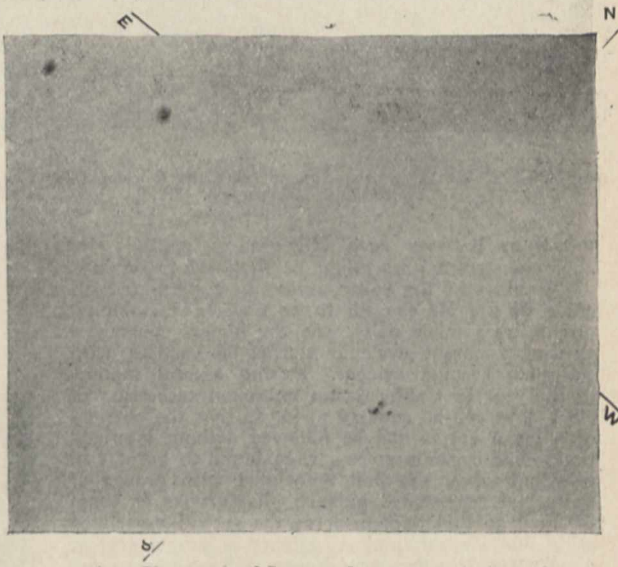


FIG. 1.—Direct Photograph of Sun-spot Group. 1908, April 30, 6h. 25m a.m. Pacific Standard Time.

enormous group of prominences, stretching for several hundred thousand miles across the sun, is much more clearly indicated by Hα than by Hδ. In general, the hydrogen flocculi are stronger and more distinct when photographed with Hα, and there are some regions which appear bright with Hα and dark with Hδ. This latter peculiarity probably has an important bearing upon the similar behaviour of hydrogen in certain stars and nebulæ, but a discussion of this question cannot be undertaken here.

The first of the Hα photographs gave strong hopes of a substantial advance in our knowledge of the solar atmosphere. The sharpness and comparatively strong contrast of these flocculi, and the evidences of definite structure and clearly defined stream lines which they revealed, were highly encouraging. The work was begun during the disturbed weather of the rainy season, when the definition of the solar image is never of the best. On April 30, 1908, the first photographs were secured under the fine atmospheric conditions which prevail in the dry season. A direct photograph (Fig. 1) shows a small and insignificant group of sun-spots, which would not seem, without other indications, to merit special attention. The next photograph (Fig. 2) shows that an enormous calcium flocculus

[1] Eruptive prominences are also recorded on the disc as bright flocculi.

occupied this region of the sun, but its form was in no wise remarkable, and afforded no evidence of the phenomena brought to light by the Hα photograph. The structure recorded with the aid of the latter line (Fig. 3) recalls Langley's sun-spot drawings, and suggests the operation of some great force related to the sun-spot group. The same cyclonic structure had been less satisfactorily recorded on the previous day, but a comparison of the two photographs

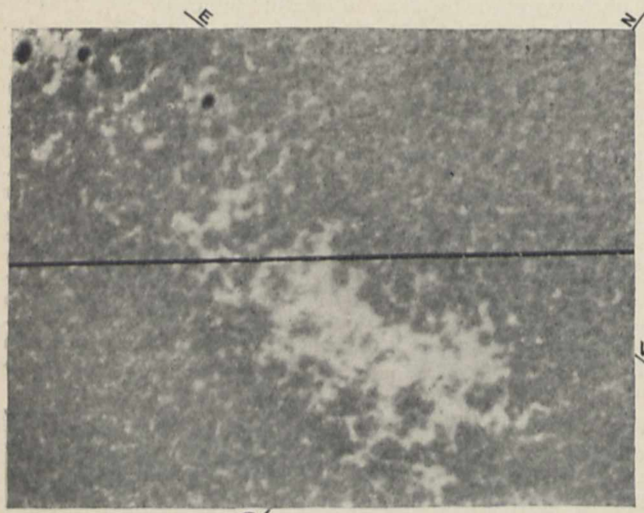


FIG. 2.—Same Region of the Sun, showing the Calcium (H_2) Flocculi. 1908, April 30, 4h. 43m. p.m. P.S.T.

failed to indicate such changes as motion along the apparent stream lines might be supposed to produce.

The close of the rainy season now permitted an active study of the Hα flocculi to be undertaken. Many photographs were made daily, and the almost constant association of apparent cyclonic storms or vortices with sun-spots became evident. During several months of the year in California an unbroken succession of clear days can be counted upon, so that the changes of a given vortex can be followed without interruption. The cyclonic storms were found to be of two principal types, the first associated with groups of spots and represented in such photographs as those of April 30 and September 2, the second associated with single spots, and resembling a simple vortex, as illustrated in the photographs of September 9 and October 7, 1908 (Fig. 4). The appearance of these simple vortices is such as to indicate rotation in a clockwise direction in the southern hemisphere, and in a counter-clockwise direction in the northern hemisphere (assuming the direction of motion to be inward toward the spot). However, this cannot be taken as a general law, corresponding to the law of terrestrial cyclones. Indeed, many instances have been found of closely adjoining spots, in the same hemisphere and frequently in the same spot-group, having magnetic fields of opposite polarity, produced by vortices rotating in opposite directions.

In some cases, at least, these vortices seem to exercise a powerful attraction on the surrounding gases, as a series of photographs taken on June 3, 1908, illustrates. A long dark hydrogen prominence, first photographed in elevation at the sun's limb on May 28, had advanced half-way across the solar disc. It lay at the outer boundary of a well-defined vortex, centred on a sun-spot. This spot had been gradually separating into two parts, and on June 3 the separation was complete. The first photograph of a series of nine was made on this day at 4h. 58m. Several successive photographs indicated no appreciable change, but one taken at 5h. 07m. showed that the prominence was developing an extension toward the spot. At 5h. 14m. this had assumed the appearance illustrated in the next photograph, and eight minutes later, when the last photograph of this series was taken, the extension had almost reached the spot. It will be seen that it divided into two parts, which indicates that each umbra was a centre of attraction. The average velocity of the motion toward the spot was more than 100 km. per second. Later photographs, made on the following days, show a ring of bright hydrogen surrounding the spots, suggesting that the comparatively cool hydrogen carried down into the spots was re-heated and returned to the surface, after escaping from the lower end of the vortex. We thus seem to be observing some of the phenomena of an actual vortex in the sun; but it must not be supposed that cases of this kind are common. In many instances the hydrogen flocculi do not appear to move rapidly toward or away from spots, but undergo changes of intensity, as though the physical condition of the gas were constantly changing; but before proceeding further with a discussion of these sun-spot vortices, let us turn to another phase of the subject, which will afford much new information indispensable for this purpose.

We are all familiar with the effect produced by passing an electric current through a wire helix. The lines of force of the resulting magnetic field are parallel to the axis of the helix, and its intensity is determined by the diameter of the helix, the number of turns of wire, and the strength of the current. We also know, from Rowland's experiment, that the rapid revolution of an electrically charged body will produce a magnetic field. Thus, if a sufficient number of electrically charged particles were set into rapid revolution by the solar vortices, a magnetic field should result. What warrant have we for assuming the existence of charged particles in the sun, and how could such a field be detected?

Let me pass rapidly in review a series of phenomena with which you are all familiar. Sir William Crookes showed in this lecture-room, so long ago as 1879, that the negative pole of a vacuum tube sends out a stream of particles, capable of setting a light windmill in rotation, and deviated from their straight path when under the influence of a magnetic field. He has kindly consented to show the same tube again to-night; you now see the

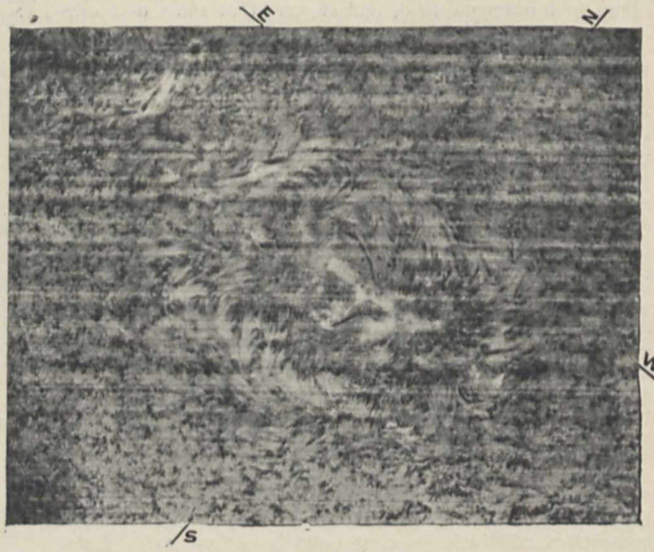


FIG. 3.—Same Region of the Sun, showing the Hydrogen (Hα) Flocculi. 1908, April 30, 5h. 06m. p.m. P.S.T.

effect upon the screen. The recent work of Sir Joseph Thomson and others has proved that these are negatively charged particles, called "corpuscles" or "electrons," and that their mass is about 1/1700 of the mass of an atom of hydrogen. Moreover, Thomson has shown that at low pressures these corpuscles are given off from a hot wire or from the carbon filament of an incandescent lamp. He has also demonstrated that this property of emitting corpuscles at high temperature is common to carbon and to metals, whether in the solid or in the vaporous condition. Thus we have warrant for the belief that the sun, composed of just such elements as constitute the earth, must emit great numbers of these corpuscles. As Thomson has estimated that the rate of emission of a carbon filament at its highest point of incandescence may amount to a current equal to several amperes per square centimetre of surface, we can hardly be mistaken in assuming the existence of still more powerful currents in the sun. The emission of negatively charged particles implies the emission of positively charged particles, but in laboratory experiments, because of unequal rates of diffusion or other causes, charges of one sign are always found to be in excess. We thus have reason to believe that powerful magnetic fields may result from the revolution of these particles in the solar vortices.

In seeking a means of detecting such fields, let us first recall Faraday's discovery of the effect of magnetism on light, made at the Royal Institution in 1846. This discovery relates to the rotation of the plane of polarisation of light when passed through a plate of dense glass in a strong magnetic field. Although Faraday, in what was said to be his last experiment, endeavoured to detect the effect of magnetism on the lines of the spectrum, he failed because the apparatus then available was not sufficiently powerful. In 1896 Prof. Zeeman examined with a large spectroscope the two yellow lines emitted by sodium vapour in a flame between the poles of a powerful magnet. Observing in the direction of the lines of force, he saw that the sodium lines widened when the magnet was excited. Subsequently, with more powerful apparatus, he found that a single line, when observed under the above conditions, is split into two components by a magnetic field. The distance between the two components is a measure of the strength of the field; but the most characteristic quality of these double lines, which distinguishes them from double lines produced by any other known means, is the fact that the light of the two components is circularly polarised in opposite directions. If, then, we encounter a double line in the spectrum of any substance, and suspect it to be due to a magnetic field, we must apply the test for circular polarisation.

The simplest means of testing for circularly polarised light is to transform it into plane polarised light by passing it through a quarter-wave plate or a Fresnel rhomb. In the case of a Zeeman doublet, we would then have issuing from the rhomb the light of the two components, polarised in planes at right angles to one another. A Nicol prism, standing at a certain angle, will transmit one of these plane polarised beams and cut off the other. Turning the Nicol through 90° will cause the component previously cut off to be transmitted, and the other to be stopped.

Consider a sun-spot at the centre of the solar disc, and suppose it to be produced by a vortex, the axis of which lies on the line passing from the eye of the observer through the spot to the centre of the sun. In these circumstances, if a strong magnetic field is produced by the vortex, the spectral lines due to vapours lying within this field should be widened or transformed into doublets. Moreover, the light of the components of these doublets should be circularly polarised in opposite directions. This would be true if the spot vapours were emitting bright lines, identical in character with those emitted by a radiating vapour between the poles of a magnet. The experiments of Zeeman, Cotton, König, and others, show, however, that dark lines, produced by the absorption of the spot vapours, should behave precisely in the same way as bright lines.

The spectrum of a sun-spot was observed for the first time by Lockyer in 1866. He found that many of the lines of the solar spectrum were widened where they crossed the spot, and the observation of these widened lines has been carried on systematically by many observers ever since. Conspicuous among these observers was Young, whose last observations were made with a powerful grating spectroscope attached to the 23-inch Princeton refractor. This instrument showed that some of the spot lines are close doublets. Dr. Walter M. Mitchell, who at first worked in conjunction with Prof. Young, and later by himself, gave special attention to these double lines, which he found to be particularly numerous at the red end of the spectrum. He called them "reversals," and the existing evidence favoured the view that they were produced by the radiation of a hotter layer of vapours overlying the spot, which would give rise to a narrow bright line at the centre of the widened dark line. True reversals of this kind actually seem to occur in the case of H and K and other lines in the spot spectrum, and it was therefore natural that Mitchell should attribute the similar phenomena of the spot doublets to a similar cause. It was generally supposed that the widening of the dark lines was due to the increased density of the spot vapours. The diverse character of the lines in the sun-spot spectrum is well illustrated by this drawing, which is due to Mitchell. In addition to the ordinary widened and "reversed" lines we find cases where a dark central line is accompanied by wings, others in which lines are thinned or completely obliterated, &c.

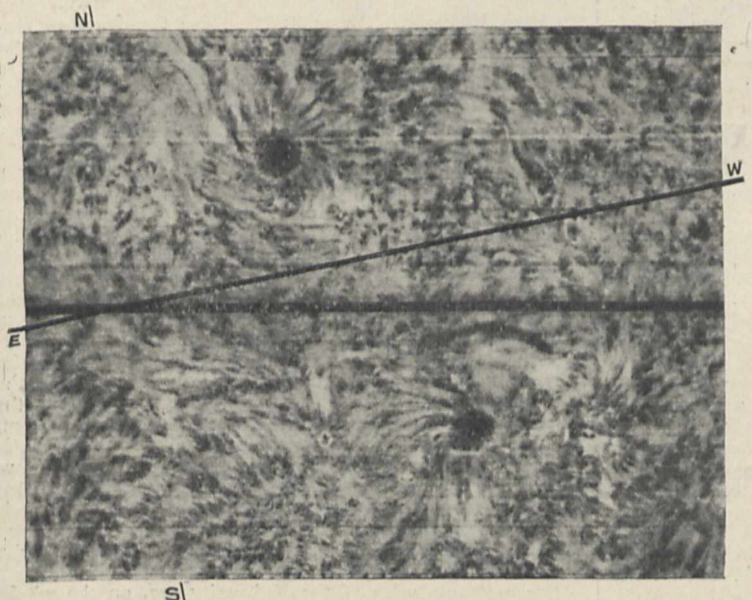


FIG. 4.—Sun-spots and Hydrogen Flocculi, showing Right- and Left-handed Vortices. 1908, October 7, 7h. 02m. a.m. P.S.T.

(*To be continued.*)

RECENT AGRICULTURAL PUBLICATIONS FROM THE WEST INDIES.

THE imperial Department of Agriculture for the West Indies issue three periodical publications:—(1) the *West Indian Bulletin*, a quarterly scientific journal containing papers or reports by members of the scientific staff, or papers read at agricultural conferences; (2) the *Agricultural News*, a fortnightly paper, published at one penny only, containing short articles in popular language on subjects of importance to planters; (3) a series of bulletins, each containing detailed information on some special subject. In addition, reports are issued on the work done at the different experiment stations on some of the islands, and the Department of Agriculture for Jamaica issues a separate bulletin of its own.

During the present year the last number of vol. ix. of the *West Indian Bulletin* and the first of vol. x. have been published. The timbers of Jamaica are described at some length by Mr. Harris, no less than 108 varieties being dealt with, and a similar article describes 176 trees found in Dominica. Dr. Watts and Mr. Tempany discuss the soils of Nevis in a very luminous paper. Mr. W. Biffen writes on soil inoculation, and describes a number of experiments made in various parts of the West Indies with Prof. Bottomley's cultures. No increase in crop was produced, excepting only in two cases; this result is, of course, quite in accordance with careful trials made elsewhere.

The *Agricultural News* is altogether distinct in type from any other agricultural paper. It consists almost entirely of scientific articles, some original and some quoted from other sources, but all bearing on the problems of West Indian agriculture. With a body of scientific men like the staff of the West Indian departments there is probably no great difficulty in getting "copy," but it is interesting and significant that the "news" should be appreciated by the planters. An interesting economic problem is raised in one of the issues. The West Indies are, of course, almost purely agricultural, yet quantities of food-stuffs are imported. In the Leeward Islands, for instance, the total value of all imports for 1906–7 was 407,251*l.*, of which 151,260*l.* was for food, viz. 46,751*l*, for wheat flour, 13,593*l.* for corn meal, 12,657*l.* for salt pork, hams, and bacon, 9127*l.* for bread-stuffs, 8537*l.* for rice, and 991*l.* for peas and beans. No doubt it is economically sound for these islands to grow for export such staple products as sugar, cacao, cotton, limes, bananas, and to import the above food-stuffs; but in many of the West Indian islands there are men unemployed and land uncultivated; moreover, crops like cotton require some sort of rotation. Why could not some scheme be evolved for raising on the spot the bulk of this imported produce? The question is discussed in a broad, masterly way in an interesting and informing article.

Of the recent pamphlets dealing with special subjects that have reached us, three relate to the sugar-cane. Experiments have been in progress some years in Antigua and St. Kitts to ascertain those varieties of sugar-cane which are likely to give improved yields of sugar, and, at the same time, to show increased resistance to disease. In the manurial trials it is found that sulphate of ammonia or nitrate of soda alone, *i.e.* without potash or phosphate, is the most profitable form of manure for ratoon canes. Sulphate of ammonia proved more useful than nitrate of soda, probably due to its being less liable to loss by leaching. Potash and phosphate still further increase the yield, but not to a sufficient extent to pay for the additional fertiliser. Dried blood did not prove remunerative. Very full details are published in a separate report. Experiments on similar lines are made at Barbadoes; the results are very similar, but the increased yield obtained by the use of potassic manures was profitable.

Jamaica has its own Department of Agriculture and publishes its own bulletin. The new series began in April of this year under the editorship of the director, Mr. H. H. Cousins, and it is well got up and illustrated with very good photographs. Mr. Cousins contributes articles in his usual lucid style on rum, cassava, starch, mangoes, and other important local industries. Mr. Ashby discusses the yeasts of the rum distilleries, and in another article the bacteria of the soil, and Mr. Harris describes the timbers of Jamaica.

THE QUINQUECENTENARY OF THE UNIVERSITY OF LEIPZIG.

THIS year, the year of anniversary celebrations, has been an *annus mirabilis* for other countries than our own. In Germany Leipzig has been commemorating her five-hundredth birthday, and Prof. Wundt, her official historiographer, had a crowded and distinguished audience before him in the theatre at Leipzig, an assemblage including the King of Saxony, the Royal princes, and many learned delegates drawn from all four quarters of the globe; but some notice must be taken of the previous history in order to understand and to preface Prof. Wundt's enthusiastic and interesting discourse.

Charles IV., the first German King of Bohemia, in 1349 established at Prague the first German university. About half a century later, and in the throes of the Great Schism, whilst Wenceslaus was still occupying the Imperial throne, there was a great national and religious revolt in all the Slav domains of the Holy Roman Empire, and in the course of this upheaval the University of Prague was nationalised by the Cechs. Then, in 1409, a small band of German teachers and students left Prague, turned their faces northwards, and founded a new home at Leipzig. Prof. Wundt's address shows how fully he realises that the spirit of those first free emigrants was perpetuated in the great school they established. For in this her voluntary uprising, Leipzig is unique among the universities of Germany; her existence might be confirmed by the princes and electors, and she might acknowledge many benefactions from on high, but she was ever independent of both city and Sovereign. Yet this independence, this tradition of liberty, was sterilising; it rested on an essential immutability; until 1830, when the University had to commit her own suicide—but was spared the public executioner—and became a State institution, she remained scholastic, manacled with fetters of an age outworn.

Prof. Wundt thinks that the present age may witness a change, as at those two epochs when humanism and science forced a reluctant way in. As Leibniz said, "The past has ever been fulfilled by the future." "Wherever we look," says Prof. Wundt, "we see the force of new needs impelling us far beyond the original objects of the universities. The universities arose out of the bosom of the Church. The State was concerned with conserving a class of learned clerics, and thus availed herself of them as schools for the making of a learned officialdom; and thus the State cut herself free from the Church in the settling of the aims of the universities. But nowadays a third power is associated with the State, and is presenting an ever-increasing tale of demands, viz. the community. Society henceforth needs the State as a means of attaining its ends, just as the Church once similarly required the resources of the State." And the modern university will present a more motley and less secluded appearance; it will have to deal with the claims of women to a university education, to admit technical high schools and pupils from *Realgymnasien* to an equality with its original *alumni*, and to extend and expand to suit the manysidedness of modern life. Leipzig, very late in the day, at last had to succumb in the fight against humanism, and had to allow the newer teaching gradually to supersede scholastics. So, too, the University had to approve natural science and the linking of research to scholarship; but the present conflict is not "as of old, a struggle between irreconcilables, of whom only one may win; rather, the task of combining the ideal of the future with the whilom new ideal of culture."

The early centuries of the University are, on the whole, undistinguished. Not even the Reformation transformed it essentially. After the model of Paris, the University was divided into four "nations," each under its dean, the Meiszners, the Saxons, the Bavarians, and the Poles; but all these ancient differences have been swept away; this only remains, that, at every annual election, the statutes of 1554 are entrusted to the new officer, and the benevolent funds for poor students still subsist. Also every professor has, like the mediæval *magister*, a *famulus*! In 1543 Maurice, the great Elector of Saxony, gave the University the old Dominican monastery of St. Paul, which was itself built on the foundations of one of the three castles erected in 1217 to cow the city. There were, as is usual in the story of university life, many town and gown riots, perhaps, as the professor suggests, survivals of the old Bohemian spirit of liberty. The University was a close corporation, rigidly scholastic, with only one faculty, theology, up to which all other branches of knowledge necessarily led; and then, too, "it was the fate of the German university that its development should have begun at a period of the decay of learning." When the sleep of the other universities was being broken by dawning humanism, Leipzig resisted longer than any other; and the University of Leipzig was regarded as an almshouse for irremovable *magistri*, and for some time, during the horrors of the Thirty Years' War, young children were matriculated in large numbers so as to secure them some legal immunity; there were only a few dozen students, so that the almshouse became a nursery as well.

In the eighteenth century the great struggle was, first, to secure admission of the German language for formal purposes, and, secondly, to ally research with study. In 1710 Augustus the Strong granted an observatory, very much in opposition to the University authorities, who, like true scholastics, deemed all teaching should be theoretical. "If a professor made chemical or physical experiments, such were utterly outside his profession. . . . Even an anatomical lecturer did something very supererogatory if, even once a term, he exhibited the position of the entrails to his class. . . ." But the *Universitas Scholastica*—not yet the actual *universitas litterarum*—even in its theoretical teaching, had to be permeated by the modern spirit, and to admit, as subjects, architecture, military science, and so forth, and even, in the *universality* of its strivings, quite technical matters, afterwards more fitly relegated to the polytechnics. Later, at the beginning of the last century, when the University of Berlin was inaugurated, Humboldt's words mark the great change. "Research and teaching must coexist, each in its place, and teacher and pupil must be partners. . . . The strength of the elder mind, more practised, but weaker and more cramped, must act in unison with the spirit of youth, less reliable but more enterprising. With this process of exchange the State must not meddle . . . it must supply the wherewithal and select the right men." So too Schleiermacher. "The teacher must be wholly free and gather round himself a seminary of fellow-seekers, thus constituting scientific research as a means to something greater, namely, a school of character." But Prof. Wundt sees two sorts of dangers ahead. First, that politics may enter into the scholastic world and affect the choice of competent instructors, and, secondly, that university teachers, though they be civil servants, may not recognise the essential differences between them and ordinary State officials, *e.g.* that such rules as promotion by seniority cannot apply to them. Instances of the former peril at Leipzig have been the enforced resignations of Mommsen, Otto Jahn, and Moritz Haupt.

One great reform the University of Leipzig has accomplished. The old foundation, professing to be universal, was little more than an ultra-conservative high-school for Saxony, in which great men found it hard to breathe freely; thus Leibniz was forced outside. But the modern State institution is at least German, and not "particularistic." The teachers are drawn from every part of Germany and German-speaking Austria, and the University, if not international, as in olden time it professed to be, is a national school of a united nation.

The early attendances at the University are difficult to gauge. The practice of matriculating children, of not including teachers and students who came in *extra ordinem* (*i.e.* not as members of the corporation), the irregularity of attendance (varying for the terms; in the winter the students mostly went home), and the inadequacy and vagueness of the old lists, all these causes make any accurate computation impossible. The average is from 350 to 450, rising between 1609 and 1629 to 800, sinking in 1634 and 1645 to less than 100. This severe fall more or less corresponds with the Thirty Years' War. Another noticeable drop (1520–40) may tentatively be accounted for by the superior attractiveness of Wittenberg (where Luther was staying) and the troubles of the Reformation. After the establishment of the present Empire the numbers rose in ten years from 700 to 2000, and in 1908 stood at more than 2300.

Prof. Wundt's long address, which is published by Mr. W. Engelmann, of Leipzig, leaves something to be desired. He gives few details as to the modern extensions of the University, of its new buildings, of the student associations, and in his estimate of the coming problems he expresses himself indecisively, perhaps discreetly. It would, too, have been interesting to be able to correlate better the progress of German history and the developments of this ancient corporation; but perhaps there is little more to be said, for, until the revolutionising change of 1830, there was little alteration. But a university with so high a claim to veneration for antiquity, so great a repute for modern achievement, could hardly have found a more distinguished commemorator.

INTERNATIONAL CONGRESS ON PURE FOODS AND ALIMENTARY SUBSTANCES.

THE second International Congress on Pure Foods and Alimentary Substances, held in Paris on October 17–24, will be memorable as having brought together more than 2000 delegates and members from all parts of the world. The actual number of countries represented was twenty-eight, and these included States so remote as China, Japan, Uruguay, Mexico, and Brazil. All the European States, as well as America and the British colonies, were fully represented.

The British delegation was a representative one, and included delegates from various learned societies and other associations interested in a pure food supply. The meetings were held in the College of Medicine, Paris, which was kindly placed at the disposal of the congress by the faculty, and the various class-rooms, together with the commodious amphitheatre, were taxed to their full capacity to accommodate all those present. Indeed, on the official opening day, October 18, it was quite impossible to find room for half the members who desired to hear the speeches. The address of welcome was given by M. Ruau, Minister of Agriculture of France, who dwelt on the great work being carried on by the White Cross Society of Geneva, under the auspices of which the second International Food Congress was held. The White Cross Society was called into existence as a companion organisation to the Red Cross Society, the efforts of which have proved so successful in mitigating the horrors of war. It is the mission of the White Cross Society to try to ameliorate the evils of our modern social system, and in no respect is this more needful than in connection with the food supply.

Prof. Bordas, chief of the customs laboratories of France, as president of the congress, reminded the members present that the first congress, which was held at Geneva, had defined what should be the constitution of pure food, primary products in connection with drugs, and various alimentary substances, all of which had been set forth in the *Comptes rendus*. It would be the business of that congress to continue these definitions and determine precisely what operations should be allowable in the handling of such substances. When that was complete it would then be necessary to try to unify analytical methods or show exactly what relation one analytical process bore to another, so that the results attained would be comparable equally. When such a basis of comparison was arrived at, it would then be easy to place the whole department of the supply of food and alimentary substances under legal control in all countries.

The work of the congress was divided up into various sections, the duty of which it was to come to definite conclusions in connection with various substances and report such decisions to the section of hygiene, which formed a kind of court for reviewing the work done in other departments.

The sections included:—(1) drinks and beverages, wines, liqueurs, cider, perry, beer, vinegar; (2) bread, flour, pastry; (3) confectionery, honey, sugar, sugar preparations, cocoa, chocolate; (4) spices, tea, coffee, mustard, salt; (5) dairying, milk, cream, condensed milk, butter, cheese, eggs; (6) charcuterie, the meat industry, edible fats, preserved provisions, preserved fruits and vegetables, sausages; (7) primary products in connection with drugs, essential oils, chemical products; (8) medicinal and other mineral waters, ice.

The consideration of such a formidable list necessarily meant continuous hard work, and it is only fair to say that the attendance at the sections was everything that could be desired, and the department of hygiene was crowded from first to last, it being estimated that in it alone the average attendance exceeded 500.

It would not be desirable to attempt to review the various discussions in detail, suffice it to say that the definitions were completed, and, as the president announced, will be published as soon as possible in French, German, and English. It may be of interest, however, to refer to some of the more notable decisions.

Bread was declared to be the product resulting from the baking of dough made from pure wheat flour, with the addition of yeast, water, and salt. Any other product meant as a substitute for bread should not bear the name, and its composition should be declared at the time of sale. It was subsequently declared that the addition of baking powder, bicarbonate of soda, and tartaric acid were quite permissible and regular operations. Alum was entirely prohibited.

Coffee was clearly defined as being only worthy of that name when derived from coffee berries and when free from any foreign mixture, such as chicory or any other substance. Cocoa, on the other hand, was not so easily defined. Long discussions on the composition of this product took place in the section, and it was agreed that it would be better to refer the matter to an international commission of experts. The main question was as to whether the addition of alkali to cocoa was justifiable or not. The large manufacturers said that it was unnecessary, but the small makers, who were in the majority, held to the view that not only was it allowable, but it was necessary, so as to enable them to produce a cheaper cocoa than that sold by the large makers, and at a cheaper price. They asserted that the buyers for whom they catered belonged to a class which could not afford the high prices asked by large manufacturers. To prohibit the use of alkali meant the practical extinction of the small makers and the creation of a vast monopoly in the hands of a few. The discussions on the subject in the hygienic section were prolonged and sometimes very heated, but in the final issue it was agreed that 2 per cent. of alkali should be allowed. An international commission will consider the whole matter, as it appears that cheap cocoas are not only sophisticated with alkalis, but additions, which are simply adulterations, are common. It is strange to hear, for example, that one manufacturer uses paraffin wax in his produce!

If the discussions on cocoa were animated, so also were those on butter. At the Geneva congress there seemed to be a feeling that the definition of pure butter was a political rather than a hygienic question, and the voting seemed to be between the fresh butter and the salt butter makers. Owing to the greater attendance at the Paris congress there was a greater body of opinion, hence the discussions were more prolonged, and, for that matter, more interesting. The first question was as to the empirical standard of 16 per cent. of water, which, it was declared, was too low for general purposes. It was finally raised to 18 per cent.

The next question was in connection with the use of preservatives, and it was shown that it was not possible to conduct an export butter trade over any great distance without the addition of some boron preservative. This addition was allowed, and classed as a regular operation (*opération régulière*), which means that it is now considered as necessary in the making of some kinds of butter as is the addition of salt, and need not, therefore, be declared. Colourings for food, confections, and liquids came in for considerable attention, and it was found impossible to resist the argument that the sale of many alimentary products depended to a large extent on their appearance, and the use of harmless colours was therefore permitted. Twenty anilines were specifically mentioned as being innocuous, and they embrace every shade used for food purposes.

The discussion of ice elicited quite a display of feeling, and an acceptable definition was not arrived at without some difficulty. It was finally agreed, however, that there were two kinds of ice, namely, manufactured and artificial. The manufactured article should be produced only from sterilised or town's water. Natural ice could only be admitted for addition to, or for bringing in contact with, foods, when gathered from lakes, rivers, or canals under proper sanitary control.

Medicinal mineral waters did not emerge from the discussions well. It appears that there is quite an industry in manufacturing these and sending them out into the world under apparently genuine labels, and the "source naturelle," or natural spring, is too often the town supply of water to which a small percentage of alkaline salts is added! To control fraud such as this is difficult, and nothing short of making it a penal offence would be of much use.

In connection with drugs, a long discussion ensued upon the presentation of a brochure by Mr. C. Umney, in which he set forth the desirability of instituting international control of specific substances, and it is not unlikely that, as the matter is of such world-wide importance, an international commission may be appointed to study the whole question in detail.

These references will show that the work accomplished was very great, for it must be borne in mind that each subject on the programme had to be discussed and resolutions arrived at. The manifest pains which were taken to arrive at correct definitions impressed those present.

The feature of this congress was earnestness and a strong desire to coordinate practice with hygienic requirements, and when the *Comptes rendus* are published it will be seen how very thoroughly the work was carried out.

It has not yet been decided where the next congress will be held. The choice lies between Rome, Brussels, and London, but a decision cannot be arrived at until later.

It may be mentioned that much hospitality was shown to the visitors. The city of Paris gave a reception at the Hôtel de Ville, and the Minister of Finance at the Ministry. Various visits to notable food factories, such as that of Messrs. Potin and the chocolate factory of Messrs. Menier, were arranged. Parties also visited the brewery of Messrs. Karcher, the Gobelins lace factory, and Sèvres porcelain works. Amongst those who dispensed lavish private hospitality were Madame and M. Paul Bolo, to whose initiative the White Cross Society of Geneva owes its origin, and whose generosity enabled it to call the first congress together at Geneva last year.

LOUDON M. DOUGLAS.

EDUCATION AT THE BRITISH ASSOCIATION.

THERE can be no gainsaying the fact that education received quite its fair share of attention at Winnipeg this year. Readers of NATURE have already had an opportunity of considering the words of warning in Sir J. J. Thomson's presidential address to the association on the excessive competition for scholarships now confronting the student of every grade in England, and on the evils which the consequent premature specialisation brings in its train—the dulled enthusiasm for knowledge and the inadequate literary culture. In the physiological section, also, Prof. E. H. Starling shed a fresh light on the meaning of the word by applying to it the conception of man as the last result of an evolutionary process.

In the Educational Science Section itself, Dr. Gray's presidential address, printed in NATURE of October 7, was concerned with "The Educational Factors of Imperialism," and in the course of it he developed an attack on the "grand old fortifying classical curriculum" with a boldness remarkable in one who is at the head of an English public school, and, as Prof. Armstrong said, is one of the most successful teachers of Greek we have.

Manitoba lags behind its younger sisters, Alberta and Saskatchewan, in that elementary education is not by law compulsory, and the pronouncement made by Dr. Kimmins, one of the vice-presidents of the section, in favour of compulsion probably attracted as much outside attention as any utterance in the section. For two days the blackboards outside the *Free Press* office, which appear to constitute the principal reading of many inhabitants of Winnipeg, informed the constant crowd that "Dr. Kimmins had expressed astonishment that education was not compulsory in Manitoba."

To the regular attendants of the section, however, the contributions of the two American vice-presidents, Prof. Hugo Münsterberg and Principal J. W. Robertson, were the outstanding features of the meeting.

Prof. Münsterberg spoke at some length on the last day of the meeting, and to a good audience, on the relations of education and experimental psychology. He began by drawing a striking contrast between the attitude of teachers here and in America towards psychology. In England psychology is neglected, and the teacher is like the farmer who turns his back on chemistry—his methods remain clumsy and old-fashioned. In America, on the other hand, the value of the subject is overestimated, and the teacher commits the grave mistake of subordinating the whole of his art to scientific psychology; but a science gives us the means, not the aim. The psychologist regards the inner life as the physicist regards the outer. He shows us how the pupil's mind imitates; he cannot tell us what is worthy of imitation. It is to ethics we must look to give us our goal before we apply to psychology for the means to reach it.

Again, the psychologist is seeking the relation of cause and effect, and for that he must analyse personality. The child's mind is to him a combination of elements, as the physical thing is a combination of atoms; and so psychological truth differs from the truth of life. The child, for the educator, is a unity to be understood, not a bundle of conditions to be described. The teacher must beware of any tendency to inhibit those emotional responses of personality to personality. Tact and sympathy and love and interest are the things which matter in educating the young.

Yet, if its dangers are well understood, the knowledge of experimental psychology ought to be at the disposal of the teacher just as experimental physics ought to be familiar to the engineer. Psychology in the past has been a strictly theoretical science, having little or no connection with practical needs; but in the last decade the connections have been made; the practical problems have been studied in the laboratory in the light of psychological facts. There is a body of psychology applied to education which the teacher can use with safety.

Of this applied psychology Prof. Münsterberg gave several interesting examples drawn from his own laboratory practice. He told us how, by experimenting with nonsense material, the effect upon remembering of repetition, of a lengthened time interval between hearing and recollecting, of reading as against writing and saying, had all been studied. He showed that the learning process is not coterminous with the process of taking in, but that a period of rest, in which the impressions settle, as it were, and organise themselves with the previous content of the mind, is requisite. He laid it down that piecemeal learning is an illusion, and that, within certain ascertainable limits, the larger the group of impressions the better they are remembered. Finally, he pointed out that it is possible to relate individuals to certain definite types, as, for instance, those whose memory is visual and those in whom it is acoustical, and indicated the relevancy of the facts, not only to the educational process, but also to the selection of a calling for the child, since every calling demands certain characteristic traits.

Dr. J. W. Robertson, the second American vice-president of the section, is the first principal of MacDonald College, which has been established at St. Anne de Bellevue, a few miles from Montreal, at the west end of Orleans Island, through the generosity of Sir William MacDonald. The college buildings alone cost nearly half a million dollars, and, standing as they do immediately north and south of the two great trunk lines of Canada, which at this point run side by side, cannot fail to attract the attention of every traveller to the western prairies. They are, indeed, a worthy monument of their founder and of the genius of the man who inspired him to build this great house of education.

Dr. Robertson addressed the section on the history and aims of the college. He described the college as an effort for the betterment of rural life in Canada. We are face to face here, he said in effect, with problems which are peculiar to ourselves—problems due to our youth, to our vast stretch of territory, to the great potential value of our resources, to the broad stream of foreign blood which is pouring into our citizenship. Wealth may come, is coming with great rapidity, but real progress and stability in national life keep side by side with progress in intelligent labour, and that depends upon education.

MacDonald College has grown out of a desire to help the rural population to build up the country and to make the most of it and of themselves. The rural school must be adjusted to the needs of the people; it must have a bearing on the life interests, the occupations, and the opportunities of the locality. From the course of study in many rural schools to-day you would not suppose that the fathers had any concern with the soil, with crops or animals. At MacDonald College we instruct and train for the three fundamental mothering occupations which nurture the race, first, farming, whereby man becomes a partner with the Almighty, and through cooperation with nature obtains food and shelter and clothing; secondly, home-making; thirdly, the teaching of the children. The training of leaders for these three fields of endeavour is being carried on in close correlation. Until recently, the teachers and the agricultural students were segregated for training, and the courses of study of neither class contained much which identified education with the activities of the home. Now the home, the farm and the school are finding common ground, to the great advantage of all three.

We are all part of nature; our lives, the transient and the eternal, are sustained by natural processes under natural laws. The study of nature, then, must lie at the root of all education. Nature-study, too, deals with the facts and principles on which a systematic study of agriculture can be founded; and next to nature-study comes manual training, which is similarly a basis for technical and industrial education. Every boy and girl should go through a course of manual training. Think of its value in the making of character. How many men there are who need the stimulus of others' approval to keep them in the right way. Here is something which the boy can assess for himself; he does not need the teacher's blue pencil to tell him whether his woodwork is right or wrong. He judges it for himself and judges himself—"that is not so good as I can make it." See, too, how it teaches the lesson of all lessons the most important, the lesson of consequences—"the joint will not fit because I did that wrong."

If the people starve the schools and colleges, the schools and colleges will retaliate by letting the people starve mentally, then morally, and in a measure materially too. "Once I saw a field of which the owner said, 'I let the crop take care of itself, and in three years there were only two small heads of wheat among the weeds.' For the bare maintenance of human life there is need for practical education." It is hopeless in a bald summary to attempt to recapture the enthusiasm, the intimacy, and the individuality of Dr. Robertson's address. Those who heard him will not soon forget the experience.

A useful discussion upon moral education was opened by Prof. L. P. Jacks. The demand for moral training has been reinforced by the growth of the imperial idea, which is awakening the national conscience and confronting the individual citizen with enlarged responsibilities. Morality cannot be made one among a number of set subjects; what is needed is the idea of an "end" under which the purposes of life may be coordinated. Loyalty to the State is such a principle. Neither can the virtues be taught on a fixed pattern; the attempt to do so leads inevitably to reaction against the idea of morality. The teacher must be content to put the truths of their environment before young minds in such a light that the facts themselves, when so explained, become incentives to morality. Mr. Hugh Richardson followed with a plea for a scientific investigation of methods and results. He pointed out how extraordinarily little evidence there is as to what results have been produced, still less is there any evidence as to which processes have produced which results. The speakers following agreed with Prof. Jacks that direct moral training was of little worth.

Prof. Münsterberg, however, thought that teachers should keep the ethical "end" always before them. There are tendencies in education to-day which are bringing weakness of character in their train. It is not wholly good that the methods of the kindergarten should be allowed to creep up the primary school and the elective systems of the high school to descend to it. The problem of education to-day is the cultivation of the power of voluntary attention. The child is naturally attracted by what is loud and bright and shining. If everything is made easy and pleasant for him as a child, as a man he will always remain in thraldom to the momentarily attractive; he will let things slide. The good life is neither easy nor pleasant; the things that matter are not loud and bright and shining.

A discussion which attracted much local interest was initiated by Dean Wesbrook, of Wisconsin, on university education, in which Mr. W. A. McIntyre, principal of the

Provincial High School and Normal School, and Principal Murray, of the University of Saskatchewan, took part. The University of Manitoba at present is hardly more than a group of science faculties supplementary to the arts courses provided in the affiliated denominational colleges. Alberta and Saskatchewan are laying the foundations of what will one day be strong State universities, and Dean Wesbrook did not disguise his opinion that this was the right course to pursue. In the course of the discussion Mr. C. R. Mann, secretary of Section L of the American Association for the Advancement of Science, spoke of the direct influence which the needs of the community at large must have upon the work of a State university.

Mr. W. M. Heller, a vice-president of the section, opened a symposium on practical work in schools with a paper on the report of the committee on practical studies, which was presented at Dublin last year. Dr. Kimmins contributed a paper on the London trade schools; Miss Lilian Clarke an address, illustrated with the lantern, on scientific nature-study in secondary schools; and Mr. W. Hewitt read a thoughtful paper on practical work in continuation schools and evening classes. Mr. Walter Sargent, of Chicago University, claimed a place in the primary-school curriculum for manual training for the purposes of industrial education. In many localities in America 80 per cent. of the children leave before the end of the primary course. These children drift into unskilled occupations, and spend often two or more years in employment which awakens no industrial interest and offers no vocational outlook. For these children an optional course should be provided, planned definitely to promote industrial efficiency. Those who argue that this would abridge the period of cultural education, already too short, were reminded that no sharp line can be drawn between cultural and industrial education. "Most of the activities which have raised men from savagery involved a utilitarian test of their result. Utilitarian is a word the meaning of which becomes more inclusive with advancing civilisation."

In the discussion on the teaching of geography Profs. Dodge, Johnston and Brigham, Mr. Chisholm, and Dr. C. H. Leete took part. To one trained in geography on the old topographical method, or want of method, who is watching its gradual displacement by the more scientific regional geography, it was novel to hear that in the high schools of the United States there is practically no serious study of regional geography. The physiographical text-books in use in America are admittedly much in advance of our own, but the advance appears to have been at the expense of the student, who, after his fourteenth year, is condemned to the study of classifications principally of land forms with reference to their origin rather than to their effect upon human and animal life. Happily, there are signs of change. Prof. Brigham's account of how he was driven back upon topography pure and simple in his endeavours to aid a young student of his own kin who was floundering in a text-book on physiography (very likely his own book!) amused his English hearers, and, it may be hoped, was not lost upon some of his brother professors across the water.

The closing discussion, on education as a preparation for Canadian life, was opened by the president, who proposes to test his theories on a farm for English public-school boys which he is establishing in the neighbourhood of Calgary. He was followed by Mr. S. E. Lang with an account of high-school work in agriculture. Miss Benson described the household science course at Toronto University, and Miss Oakley gave an account of the similar course at King's College, London. Mr. Eggar spoke of the value of school games. If the principle that it was better to lose a game than to win it unfairly were true, then school games had a grand moral as well as a physical effect.

An account of the proceedings would be incomplete without some mention of the collection of brush drawings by pupils of the Village Hall School, Weybridge, which Mr. T. S. Marvin's pertinacity had brought intact through the Canadian customs. This interesting exhibit had been designed to help children in Canadian schools to realise the conditions of child life in England. There were series of brush drawings illustrating rooms in English houses, methods of going to school, bric-à-brac, portraits of the artists, and so on. Nature-study was illustrated by sketches of plants characteristic of the different months, and studies of the seasonal growth and decay of common wild flowers. The purpose of the drawings was excellent, and was carried out in a charming fashion. The nature-study work reached a high standard of accuracy, and almost all the drawings showed great artistic merit. It is pleasant to think that the collection will remain in Manitoba to pay a double debt—as a token to the educators of the province of our gratitude for their efforts on our behalf and as a reminder to the children of their child cousins on the other side of the sea.

CONFERENCE OF DELEGATES OF THE CORRESPONDING SOCIETIES, BRITISH ASSOCIATION.

IF the annual conference of delegates of the local societies in correspondence with the British Association had been held at Winnipeg, it is not likely that many societies in this country could have sent representatives. It was consequently decided to hold an autumn conference in London, as was done after the South African meeting four years ago. Accordingly, a conference was held on Monday and Tuesday, October 25 and 26, in the rooms of the Geological Society at Burlington House, under the chairmanship of Prof. A. C. Haddon, F.R.S. As many of the delegates from the provinces arrived in London on the preceding Saturday, an official visit to Kew Gardens was made on Sunday afternoon, when the delegates were received by Lieut.-Colonel Prain, F.R.S., and Dr. O. Stapf.

The conference was opened on Monday morning by an extemporaneous address from the chair, in which Dr. Haddon urged the local societies to carry out observational work of an original character. Regional surveys might well be undertaken. Intensive work in the special areas within range of the activities of the respective societies would ultimately lead to a close knowledge of the whole country. Dr. H. R. Mill's detailed study of a district in the south-east of England was naturally held up as a model; and reference was also made to the excellent work of Prof. A. W. Clayden on the origin of the scenery of Devonshire, and to that of Prof. W. W. Watts on Charnwood Forest. Turning to our rivers as a suitable subject for local study, Dr. Haddon referred to the work of Prof. W. M. Davis, remarking, incidentally, that it was rather strange an American should have to teach us how to read the story of our own streams. With regard to zoology, the chairman explained that when he worked under F. M. Balfour he was an enthusiastic embryologist. Notwithstanding the advance of special work in the higher departments, there was still ample room for the amateur in zoology. Anthropometry, again, was a subject that might well be taken up by the local societies.

A paper on national anthropometry was read by Mr. J. Gray, the secretary of the anthropometric committee of the British Association. He explained the methods of measurement, and exhibited on the screen the excellent figures prepared by the late Prof. Cunningham to define the exact points of reference on the living subject, from which measurements should be taken. The instruments used are inexpensive and their use not difficult, so that, in the absence of a national system of anthropometry by a Government department, the natural history societies in each county might well undertake the work. A demonstration was given, and many of the delegates were measured. Attention was also directed to the various means now used to estimate quantitatively certain mental faculties.

A prolonged discussion was initiated by Prof. Meldola, F.R.S., who desired to elicit from the delegates their opinion as to the expediency of establishing a fund, with Government aid or otherwise, for the purpose of assisting scientific societies in the publication of original work. Many societies were crippled by insufficient means, and it was believed that much good work in the country remained unpublished, or, if published, was insufficiently illustrated, whilst in many cases the proportion of income expended on publications was so great as to hinder the activity of the societies in other directions.

Sir Alexander Pedler, F.R.S., explained how the British Science Guild had sought to relieve the scientific societies by endeavouring to obtain a reduction in the rate of postage of their publications, but he much regretted that the Postmaster-General, though sympathetic, could not see his way to grant such relief. Some of the delegates suggested a renewal of the application, but it seemed unlikely that this would be successful. The general question of founding a publication fund was discussed by representatives of many scientific societies, including the Chemical, the Royal Astronomical, the Zoological, the Entomological, the Royal Anthropological Institute, and the Institution of Mining Engineers.

In a paper on the financial position of our local societies, Mr. John Hopkinson sketched the history of the Hertfordshire Natural History Society, and showed how a society which had always struggled with a small income had yet managed to publish excellent original work.

Although the opinion of the conference was generally favourable to the formation of a publication fund, a few speakers expressed the opinion that it would be inexpedient to take any step which might tend to increase the publications of local societies, inasmuch as the mass of such literature was already embarrassing to the bibliographer.

On the afternoons of Monday and Tuesday the delegates visited, under scientific guidance, the Natural History Museum and the Zoological Gardens.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An election to the Clerk-Maxwell scholarship will take place at the end of this term. Candidates are requested to send in their names to Sir J. J. Thomson on or before December 1.

Dr. G. H. F. Nuttall has been re-elected to the Quick professorship of biology. Mr. J. S. Gardiner has been elected to the professorship of zoology and comparative anatomy. Mr. E. O. Lewis has been appointed demonstrator of experimental psychology until Michaelmas, 1911; and Mr. D. G. Lillie has been elected to a Hutchinson research studentship for natural science.

Mr. H. F. Tiarks has supplemented Messrs. J. Henry Schröder and Co.'s gift of an endowment of a professorship of German by placing at the disposal of the University the sum of 5000*l.* for the endowment of one or more scholarships for the encouragement of the study of German in the University.

IT is announced in *Science* that Mr. Andrew Carnegie has subscribed 20,000*l.* to McGill University as a part of the general fund of 400,000*l.* which friends of the University are trying to raise.

THE Black Bear Press, Cambridge, has sent us a copy of the first issue of a new weekly magazine, the *Gownsman*, which is to be a record and comment of university life. The contents range over every department of university activity—academic, athletic, social—and the periodical should appeal to all Cambridge men, past and present. With this first issue is published, as a supplement, an excellently reproduced portrait of Sir Joseph Thomson, F.R.S. The price of the new publication is 2*d.* weekly.

THE annual meeting of the Association of Teachers in Technical Institutions will be held on November 6 at St. Bride Institute, Fleet Street, E.C. The chair will be taken at 3 p.m. by Mr. J. Wilson, who is the president of the association for the coming year. The report of the council will contain an abstract of the educational and professional work accomplished during the year. The educational work comprises the consideration of such questions as syllabuses in such subjects as applied mechanics and electrical engineering, the training of craftsmen, the preliminary training of technical students, and the Royal Commission on university and higher education in London.

IN his inaugural address, at the beginning of the present session, the president of Harvard University, Dr. A. Lawrence Lowell, discussed an ideal college training from three points of view. He considered the highest development of the individual student, the proper relation of the college to the professional school, and the relations of the students to one another. Each line of thought led him to the same conclusion. The best type of liberal education in our complex modern world aims at producing men who know a little of everything, and something well. The essence of a liberal education, said Dr. Lowell, consists in an attitude of mind, a familiarity with methods of thought, an ability to use information rather than a memory stocked with facts, however valuable such a storehouse may be. No method of ascertaining truth, and therefore no department of human thought, ought to be wholly a sealed book to an educated man. It has been truly said that few men are capable of learning a new subject after the period of youth has passed, and hence the graduate ought so to be equipped that he can grasp effectively any problem with which his duties or his interest may impel him to deal. In the present age some knowledge of the laws of nature is an essential part of the mental outfit which no cultivated man should lack. He need not know much, but he ought to know enough to learn more. To him the forces of nature ought not to be an occult mystery, but a chain of causes and effects with which, if not wholly familiar, he can at least claim acquaintance; and the same principle applies to every other leading branch of knowledge.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 26.—M. Bouchard in the chair.—E. L. **Bouvier**: The phenomena which characterise the change of nest in the ant *Messor barbarus*. A detailed account of the curious habits of these ants when exchanging nests.—M. **Gouy**: The constitution of the electric charge at the surface of an electrolyte.—Armand **Gautier**: Remarks on the second International Congress for the Repression of Fraud in Food and Drugs, held at Paris, October 18 to 23.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the second quarter of 1909. Observations were possible on sixty-three days, the results being summarised in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Charles **Nordmann**: The temperature of β Perseus (Algol). Taking 6000° as the temperature of the sun, the application of Planck's law leads to 22,900° as the temperature of Algol. This is nearly identical with the temperature (23,800°) found previously by a totally independent method. —M. **Javelle**: Halley's comet. Observations of the comet made with the large equatorial at Nice. On October 12 it appeared as a small round nebulosity, 10″ to 15″ in diameter, with a central nucleus of the fourteenth to fifteenth magnitude.—R. **Jarry-Desloges**: Observations on the surface of the planet Mars. Two diagrams accompany this paper, showing the details perceived during July, August, and September, 1909.—G. **Athanasiadis**: The influence of temperature on the phenomena of polarisation in the electrolytic valve. The potential difference, producing a definite current in the electrolytic valve, diminishes as the temperature increases.—L. **Gay**: The vapour pressure of mixed liquids. A new demonstration and generalisation of the formula of Duhem-Margules.—G. **Belloc**: The emission of gases by heated metals. A definite volume of gas can be extracted by heating a metal such as steel to a definite temperature in a vacuum. If the metal is allowed to cool, the vacuum being maintained, a re-heating to the same temperature after an interval of some days gives rise to a fresh amount of gas, and this process can be continued; even after seven heatings small amounts of gas continue to be evolved.—Maurice **Coste**: The transformations of selenium. Exact measurements of the density of selenium submitted to various treatments have been made.—E. **Cornec**: Cryoscopic study of the neutralisation of some acids.—Maurice **Barrée**: The points of transformation of the copper-aluminium alloys as determined by a study of the variation of electrical resistance with temperature.—Georges **Darzens** and M. **Rost**: Hexahydrophenylacetylene and hexahydrophenylpropiolic acid. Starting this hexahydroacetophenone,

$C_6H_5.CO.CH_3$, this was converted into $C_6H_{11}.CCl:CH_2$ by the action of phosphorus pentachloride, and from this hexahydrophenylacetylene is obtained by the action of potash. The sodium derivative of this, with carbon dioxide, gave sodium hexahydrophenylpropiolate, some derivatives of which are described.—H. **Arsandaux**: Contribution to the study of the laterites.—Marin **Molliard**: Can the amines serve as food for the higher plants? Contrary to the results of Ville and of Lutz, the author's experiments lead to the conclusion that none of the amines can act as food substances for the higher plants.—I. **Borcea**: The origin of the heart, the vascular migratory cells, and the pigmentary cells in the Teleostea.—A. **Imbert**: The fatigue produced by rapid movements.—C. **Fleig**: The action of radio-active mineral waters and of artificial serums on the survival of organs or isolated cellular elements of the body.—Maurice **de Rothschild** and Henri **Neuville**: Remarks on the okapi.—A. **Monvoisin**: The acidity of the milk of tuberculous cows. The low acidity of tuberculous milks depends principally upon the diminution in the amount of casein present.—Alfred **Angot**: The earthquake of October 20–21, 1909. The seismograph records at the Parc Saint-Maur Observatory indicate that this earthquake, no mention of which occurs in the newspapers, must have been very violent. Its epicentre was probably in the Himalayas or neighbouring mountainous regions.—E. A. **Martel**: The subterranean river of Labouiche or La Grange (Ariège).—V. **Crémieu**: A new determination of the Newtonian constant. The torsion-balance method, described in a previous paper by the author, gives a value of $K=6{\cdot}674\times10^{-8}$, the accuracy estimated being of the order of 1 in 10,000.—H. Hildebrand **Hildebrandsson**: Some remarks on the temperatures of summer in various parts of Europe.

CALCUTTA.

Asiatic Society of Bengal, October 6.—J. C. **Brown**: Stone implements from the Tongyueh district, Yünnan Province, western China (with a short account of the beliefs of the Yünnanese regarding these objects). A description of a representative series of twelve stone implements selected from numerous specimens recently examined in Tongyueh is given. Nine of these specimens are fashioned from varieties of jadeite, the other three being cut from red slate-like, white quartzite, and igneous rocks. The Yünnanese attribute a celestial origin to these stones, which they believe to possess occult medicinal properties and to be efficacious in the treatment of obdurate diseases in which the medical treatment has failed to produce any beneficial results. Descriptions of the specimens are subjoined.—H. E. **Stapleton**: (1) An alchemical compilation of the thirteenth century A.D.; (2) contributions to the history and ethnology of north-eastern India, i.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 4.

ROYAL SOCIETY, at 4.30.—(1) The Development of *Trypanosoma Gambiense* in *Glossina palpalis*; (2) A Note on the Occurrence of a Trypanosome in the African Elephant: Colonel Sir David Bruce, C.B., F.R.S., Captains A. E. Hamerton and H. R. Bateman, R.A.M.C., and Captain F. P. Mackie, I.M.S.—On the Perception of the Direction of Sound: The Lord Rayleigh, O.M., F.R.S.—The Diffraction of Electric Waves: Prof. H. M. Macdonald, F.R.S.—On the Mechanism of the Absorption Spectra of Solutions: Robert Houstoun.—(1) Note on the Spontaneous Luminosity of a Uranium Mineral; (2) The Accumulation of Helium in Geological Time, II: Hon. R. J. Strutt, F.R.S.—On the Physical Properties of Gold Leaf at High Temperatures: J. C. Chapman and H. L. Porter.—The Dimensions and Function of the Martian Canals: Dr. H. C. Pocklington, F.R.S.

LINNEAN SOCIETY, at 8.—Some Account of the Field-botany of Namaqualand, Damaraland, and South Angola: Prof. H. H. W. Pearson.

RÖNTGEN SOCIETY, at 8.15.—Presidential Address: C. E. S. Phillips.

FRIDAY, NOVEMBER 5.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Huxley Memorial Lecture. The North European Race: Prof. G. Retzius.

MONDAY, NOVEMBER 8.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Journeys in Bhutan: J. Claude White.

TUESDAY, NOVEMBER 9.

ZOOLOGICAL SOCIETY, at 8.30.—Some Living Shells, their Recent History, and the Light They Throw on the Latest Physical Changes in the Earth: Sir Henry H. Howorth, K.C.I.E., F.R.S.—The Asiatic Fishes of the Family Anabantidæ: C. Tate Regan.—On a Small Collection of Mammals from Egypt: J. Lewis Bonhote.

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

THURSDAY, NOVEMBER 11.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Vacuolation of the Blood-platelets—An Experimental Proof of their Cellular Nature: H. C. Ross.—Further Results of the Experimental Treatment of Trypanosomiasis—being a Progress Report to a Committee of the Royal Society: H. G. Plimmer and Captain W. B. Fry.—*Hillhousia mirabilis*, a Giant Sulphur Bacterium: G. S. West and B. M. Griffiths.—The Modes of Division of *Spirochaeta recurrentis* and *S. duttoni* as observed in the Living Organism: H. B. Fantham and Miss A. Porter.

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

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

FRIDAY, NOVEMBER 12.

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

ROYAL ASTRONOMICAL SOCIETY, at 5.

CONTENTS.

PAGE