THURSDAY, SEPTEMBER 8, 1910.

ORE DEPOSITS.

(1) *The Ore Deposits of South Africa.* By J. P. Johnson. Part ii., The Witwatersrand and Pilgrims' Rest Goldfields and Similar Occurrences. Pp. vi+51. (London: Crosby Lockwood and Son, 1909.) Price 5*s.* net.

(2) *The Geology of Ore Deposits.* By H. H. Thomas and D. A. MacAlister. Pp. xi+416. (London: E. Arnold, 1909.) Price 7*s.* 6*d.* net.

(1) THE second part of Mr. Johnson's "Ore Deposits of South Africa," of which the first part was reviewed in NATURE, June 3, 1909, vol. lxxx., p. 395, deals with the goldfields of the Transvaal. The book is intended for the use of prospectors and students, and consists of brief descriptions of each mining field and of short discussions of the genesis of the ores. It is illustrated with sections of the mines, and outline maps of which the shading is not always clearly explained. The author gives an excellent summary of the arguments for the placer and impregnation theories of the origin of the Rand ores, and says that "judging them on their own evidence the writer would unhesitatingly class them as detrital ore deposits" (p. 17). He suspends judgment, however, from the consideration that the gold at Pilgrims' Rest is due to impregnation. The ores at Pilgrims' Rest are quartz stringers in dolomite and altered dolomite; and they are doubtless of the same origin as those in the dolomites of South Dakota, which are strikingly different in all essential characters from the banket of the Rand. Mr. Johnson's remark that the analogy between the ores of Pilgrims' Rest and of the Rand is the strongest argument in favour of the impregnation theory for the banket is not complimentary to the other arguments. The most useful parts of the book are the chapters on the less-known secondary goldfields of the Transvaal.

(2) Messrs. Thomas and MacAlister's "Geology of Ore Deposits" agrees with Mr. Johnson's book in the conciseness with which it summarises the structures of various mining fields. It is, however, world-wide in its range. It should prove of great service as a text-book to students of economic geology who desire a clear statement of current theories. As the authors, in 416 small pages, state the principles of ore formation and explain them by reference to occurrences in nearly every mining country, the work necessarily suffers by extreme compression. There are no references to authorities, and, owing to their absence, the reader is sometimes left in doubt whether evidence opposed to the authors' conclusions has been weighed and rejected or has escaped their diligent search. An omission that might have been avoided is an index of localities. The same mining field may be referred to in different chapters, and so many mining localities are mentioned that a geographical index would have added greatly to the usefulness of the book as a work of preliminary reference. Some statistics of ore yields would also have been an advantage as showing the relative importance of the different processes of mineral deposition; the authors mention some insignificant ore occurrences which are of no economic importance, and some of which have not been worked, and inferences drawn from them as to the origin of the larger ore masses may be invalid. Owing to the wide range of the book it is not surprising that it contains small mistakes, both geological and geographical, in reference to foreign mining fields.

The classification of ores adopted by the authorities is based solely on genetic grounds. They describe first the ores due to the segregation of metals in igneous rocks, a process to which the authors perhaps attach undue importance, judged by the economic value of the ores thus produced. In succeeding chapters they describe ores due to pneumatolysis, to the action of heated solutions resulting from igneous intrusions, to metasomatic replacement, to metamorphism, to precipitation, and to the deposition of detritus. A special chapter describes the changes in ore deposits apart from those included under metamorphism. The authors show remarkably wide acquaintance with the literature of ore deposits and a sound and cautious judgment. They accept the detrital origin of the gold in the Rand Banket, and reject the view that nuggets are formed by deposition from solution in the drifts wherein they are found. The accounts of the British and especially of the Cornish ores are the best in the book, many of the references to the foreign fields being too brief to do more than show the place assigned to the ores in the authors' classification.

One significant and interesting feature in this book is the complete abandonment in a British text-book of that morphological classification of ores which was for so long dominant in this country that it has been described as "*the* British classification."

J. W. G.

OBSERVATIONAL METEOROLOGY.

Meteorology, Practical and Applied. By Sir John Moore. Second revised and enlarged edition. Pp. xxvii+492. (London: Rebman, Ltd., 1910.) Price 10*s.* 6*d.* net.

DURING the last fifteen years much progress has been made in the study of meteorology, as a comparison between the first and second editions of Sir John Moore's treatise amply demonstrates. Expansion in some directions necessitating curtailment in others has changed and improved the work. As an example of addition we may instance the account of the investigation of the upper atmosphere with the information acquired of the isothermal layer and the behaviour of air currents. This inquiry, practically limited to the interval between the appearance of the two editions, has reacted, in various ways, traces of which will be found in the book. It has given a strong impulse to the work of designing accurate self-recording instruments, necessitating a considerable increase in the chapters devoted to the methods of measurement and registration of climatic factors. Through the increased attention attracted to meteorology and the firmer scientific foundation thus acquired, there has arisen the

necessity for a broader, more general view of the factors of operation, in which world-wide areas and cosmical influences are substituted for limited districts and local circumstances. This more philosophic view the author has not discussed with the fulness its importance deserves. Perhaps, it hardly comes within the scheme, but the omission indicates the position the book occupies among treatises on meteorology. It deals with the mechanical processes employed in observation and the discussion of the results obtained, rather than with the problems of general circulation affecting the atmosphere as a whole. It is an admirable treatise on the methods of observation, it demonstrates very satisfactorily what can be accomplished by instrumental means, and what are the objects and advantages to be gained by the systematic collection of details. The principles underlying this aspect of practical meteorology are well illustrated by the description of the official weather service at home, in the United States, and in Canada. This information is thoroughly modern, trustworthy, and interesting. One section is devoted to the consideration of climate as deduced from the records supplied by instrumental means and one to the influence of season and of weather on disease. Perhaps the last is a larger subject than can be discussed adequately in the space allotted to it, but it is a subject on which the writer is an authority, and constitutes an important branch of meteorological science.

ABSTRACT AND OTHER PHILOSOPHY.

(1) *Gustav Freytags Kultur- und Geschichtspsychologie: Ein Beitrag zur Geschichte der Geschichtsphilosophie.* By Dr. Georg Schridde. Pp. ix+95. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1910.) Price 3 marks.

(2) *Lessings Briefwechsel mit Mendelssohn und Nicolai über das Trauerspiel.* By Prof. Dr. Robert Petsch. Pp. lv+144. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1910.) Price 3 marks.

(3) *Hegels Asthetik im Verhältnis zu Schiller.* By A. Lewkowitz. Pp. 76. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1910.) Price 1.80 marks.

(4) *Uber Christian Wolff's Ontologie.* By Hans Pichler. Pp. 91. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1910.) Price 2 marks.

(5) *Zwei Vorträge zur Naturphilosophie.* By Hans Driesch. Pp. iv+38. (Leipzig: Wilhelm Engelmann.) Price 80 pfennigs.

(1) GUSTAV FREYTAG is best known in England as a novelist, and chiefly as the writer of that charming story of German commercial life, "Soll und Haben," which has been translated and published in English as "Debit and Credit." But Freytag was more than novelist. He was also poet, dramatist, and thinker. Born in 1819, and living until 1895, his life—as Dr. Schridde remarks—shows us the very heart-beat of the century, a century of tremendous importance in the history of his country. Politically he was strongly for Bismarckian unification, with Prussian supremacy; philosophically he may roughly be classed as Hegelian, though less abstract, and thus he is also religious, for his "metaphysic transfigures the desiderated calmness, the white light of Reason, into religious faith." Dr. Schridde gives a good account of the influence upon Freytag of Kant, Fichte, Humboldt, Schelling, and Hegel, and is thoroughly in sympathy with his subject, though not refraining from criticism of weak places.

(2) This is a collection of letters exchanged by Lessing, Moses Mendelssohn, and Nicolai, on the subject of the correct principles of tragedy. The proper mixture of sympathy and fear—the two chief emotions to be aroused—is discussed, and the distribution of sorrows among the characters. The hero must be the most severely handled by Fate; as to whether the end shall see virtue rewarded or not, this may be left to the dramatist's discretion. There is much discussion of Corneille, Cibber, and the Greek playwrights, but very little mention of Shakespeare, who was discovered for Germany by Schlegel and Goethe.

(3) This is supposed to be a comparison of the æsthetic of Hegel and Schiller, but as a matter of fact it is mainly concerned with the former. The scheme of the booklet may be guessed by the section titles:—"Idea of the Absolute Spirit," "Idea of the Beautiful," "the Beautiful and the Development of the World Spirit," "Art and Metaphysic," &c. Hegel is good for the metaphysically inclined reader who wants "something craggy to break his mind upon," but to many readers the time spent in wrestling with him seems wasted.

(4) Another typically German pamphlet. Our Teutonic cousins still retain their interest in abstract thought and—in spite of Kant—in the "ontological proof" which, since Comte and Spencer, has become almost extinct in France and England. Herr Pichler gives an amusing parody of the ontological axiom (that as every something must be grounded in either something or nothing, and as nothing can come out of nothing, every something must be grounded in something real) by suggesting that every man has stolen either something or nothing. To take away from nothing is no theft, therefore every man has stolen something. The reader may be left to worry out the fallacy for himself, with a hint to remember "ambiguous middle term."

(5) These two lectures, as we are informed in the foreword, are connected by the chronology of their delivery rather than by their contents. But Dr. Driesch—who, by the way, was Gifford lecturer at Aberdeen two years ago—always has something to say, and no reader will complain of discontinuity in this pamphlet, even if it exists.

Dr. Driesch is a biologist; and, in opposition to the school which has for some time been dominant, he is a vitalist. He holds that life has its own laws; that biology is not merely applied chemistry-physics, but is a thing for itself; that the materialistic or mechanical view of living substance is false. His philosophic position approximates to that of Sir Oliver Lodge in England, and his arguments in support of his opinions are most weighty and—the present reviewer ventures to say—convincing.

COLOUR CHEMISTRY.

A Manual of Dyeing: for the Use of Practical Dyers, Manufacturers, Students, and all Interested in the Art of Dyeing. By Prof. E. Knecht, C. Rawson, and Dr. R. Loewenthal. Second edition. Vol. i., pp. xii+371. Vol. ii., pp. 372–902. (London: C. Griffin and Co., Ltd., 1910.) Price 45*s.*, two vols.

THE first edition of this work was reviewed in NATURE on June 22, 1893, and in the seventeen years which have elapsed since its publication, such rapid developments have taken place in colour chemistry that certain sections of the book have for some time been out of date, and the whole work has for several years been out of print. The issue of the present edition has, therefore, involved a very complete and laborious revision, and this no doubt accounts for the somewhat protracted delay in its issue.

This raises the question whether, for the sake both of authors and purchasers, some scheme could not be devised for arranging and binding a book of this type in such a manner that sections could be re-written and issued separately.

The general scheme of the book has not been materially altered, but vol. iii. of the first edition, which consisted of illustrative dyed patterns, has not been reproduced, and in this the authors have been well advised.

The section dealing with the theory of dyeing processes has been extended to three times its original length, but any general agreement with regard to the theory of dyeing does not at present appear possible, nor have theoretical considerations in the past been of much service in connection with the practical application of colouring matters. It is to be hoped that further investigation will lead to such a unification of ideas that theory may fulfil its proper function of a sign-post for those seeking new fields of practical application.

In the section dealing with textile fibres, five excellent plates replace the older diagrammatic illustrations. While the ordinary fibres are adequately described, the treatment of artificial silk seems hardly to have received that attention to which its present great commercial importance entitles it. There is, for instance, no reference to Thiele silk, one of the chief products now used.

Part vi. comprises a description of the natural colouring matters, and in this section it has been found possible to condense the matter originally published, this being in agreement with the diminished importance of these dye-stuffs from the practical point of view. The recent work of A. G. Perkin, v. Kostanecki, Schmidt, and others, on the constitution of the colouring matters of the natural dye-stuffs, is duly referred to.

The most extensive section of the book is, of course, that dealing with the artificial dye-stuffs, and this has required the greatest amount of revision. Certain entirely new groups of dyes, such as the artificial vat colours, have been introduced since the publication of the first edition, and other groups, such as the sulphide dyes, have been greatly enlarged. Some mention of Tyrian purple might well have been included in view of P. Friedlaender's discovery that it is a dibromindigotin.

A section of the work to which great importance has always been attached is that dealing with the analysis and valuation of materials used in dyeing, and this has received a very thorough revision.

The book in its new edition will again take its place as one of the most important works published on colouring matters and their application.

OUR BOOK SHELF.

La Métallographie Microscopique. By Louis Révillon. Pp. 176. (Paris: Gauthier-Villars, n.d.) Price 3 francs.

THIS is another volume of the small Aide-Mémoire series by the author of the work on "Special Steels," which was reviewed some time ago. Considering the size and price of the book, a good account of the subject is given, though, in common with many other enthusiasts, the author is inclined to claim too much for his subject, p. 7, "et de résoudre tous les problèmes . . .," and in describing the preparation of the polished face of the section for examination, is too severe in his conditions, namely, "perfectly polished so that there remains no scratch visible at the highest power of the microscope." Much time has been wasted in the past in striving after this ideal. It is not necessary, unless when looking for the finest cracks, and, combined with a somewhat elaborate series of precautions, is apt to discourage the reader from beginning practical work. Advice such as that given on pp. 69 and 70 has always been impressed on beginners by the writer, namely, that the section is prepared for observation and study, not merely for photographing, and that the polished section should always be examined carefully before etching in any way, as then small holes, oxides, scoriæ, and sulphides are generally much more easily seen against the polished metallic surface than after etching.

With many of the opinions expressed one cannot agree. The Martensitic interlacing needles do not represent the structure of properly hardened carbon steels, and many practical points might also be controverted, but the work as a whole gives a very fair introduction to a study of the subject from the point of view of a portion of the French school. Osmondite is given, although M. Osmond has specifically repudiated it in *Revue de Métallurgie*. Separate chapters are devoted to special steels, the alloys of copper, other industrial alloys, and the final chapter to the interesting "Macrographie." A. MCWILLIAM.

Die Kraftmaschinen. By C. Schütze. Pp. vi+235. (Leipzig: Quelle and Meyer, 1909.) Price 1.80 marks.

THIS little volume is devoted to a non-mathematical description of the various types of motors now employed for power purposes, and of the more important details of each class; windmills, waterwheels, and turbines, steam, gas, and petrol engines, and dynamos and electric motors are all in turn discussed and described. The text is illustrated by a large number of figures, mostly line illustrations, and, as all minute details are omitted, these illustrations will be easily understood and followed by the non-technical reader. The whole volume is, in fact, intended for those who are not experts in this branch of engineering. It will appeal, however, to many who use motors for business

or pleasure, and desire to have some knowledge of the principles underlying the design and working of the particular machines they employ. The steam turbine has been rather inadequately treated in comparison with the reciprocating steam engine, but perhaps this was inevitable in a book of this nature, as the latter is still practically unchallenged by its younger rival in many branches of work in which motive power is required.

This is a book which will probably stimulate many of its readers to widen their knowledge of the problems concerned with the generation of energy, and to devote themselves to a systematic study of the subject, and, if it fulfils this, it will have done useful work. T. H. B.

Photomicrographs of Botanical Studies. Pp. 62. (Manchester: Flatters, Milborne and McKechnie, Ltd., n.d.) Price 2*s.* net.

THIS booklet contains about a hundred plates, which are photographic reproductions from the microscopical slides offered by the firm above-mentioned for the use of botanical students. The chief impression conveyed by the figures is the limitation imposed upon good microscopical preparations when referred to one focal plane as necessitated by photography. While the value of good slides for demonstration and examination by students is appreciable, one cannot attach much importance to figures which are primarily indices and convey in many cases only a portion of the information that can be derived from the preparations.

Illustrated Guide to the Museum of the Royal College of Surgeons, England. Pp. vi+132. By Prof. Arthur Keith. (London: Issued by order of the Council of the College, and sold by Taylor and Francis, 1910.) Price 6*d.*

FEW even of those who constantly make use of the College of Surgeons' Museum can be aware of the vast wealth of material stored there. For it contains not only the greatest anatomical collection in existence, representative of everything included under the term "anatomy" in its widest sense; but it also includes a unique pathological museum, and collections illustrating anthropology, teratology, odontology, and the anatomy of animals and plants, each of which, if standing alone, would make a famous museum. Nor does this exhaust its claims on our interest, for in it is housed the famous collection made by John Hunter, innumerable anatomical and pathological preparations that have served as material for the master-builders of the sciences of anatomy and pathology, and specimens illustrating the history of all that relates to the preservation of dead bodies (starting from the earliest known mummy), the evolution of surgical and dental instruments, and the manifold curiosities of medical science which at various times engaged the attention of the ever-inquisitive Hunter.

The council of the college has earned the gratitude of a very wide circle of students in issuing this "guide," which admirably serves its purpose of indicating what the museum contains and where the various specimens are to be found, and Prof. Keith deserves our heartiest congratulations on the manner in which he has accomplished his task. For he has done something more than merely direct the reader in his wanderings through the vast storehouse of treasures in his charge; out of the abundance of his knowledge and erudition he has crammed a vast amount of interesting and suggestive information into this small volume.

This is only one, and by no means the least, of the many great services which have already marked Dr. Keith's conservatorship of the college museum.

The Photographic Annual, 1910–11, Incorporating the Figures, Facts, and Formulae of Photography. A Guide to their Practical Use. Edited by E. J. Wall. Sixth edition; extended, largely re-written, and revised. Pp. viii+287. (London: G. Routledge and Sons, Ltd.; Dawbarn and Ward, Ltd.; New York: Tennant and Ward; Melbourne: Baker and Rouse Proprietary, Ltd., 1910.) Price 1*s.* net.

EVERY photographer knows the value and utility of this annual issue, and that this is the sixth issue is sufficient testimony to its merits. There is no doubt that, in preparing such a work as this, and to keep the volume within a reasonable size, great difficulty must be experienced in determining what information to include or omit. The editor has used his discretion wisely, with the result that the present issue should meet with general approval among photographers.

The importance and recent advances made in screen-plate colour-photography is sufficient reason for the first forty pages being devoted to this subject, and here the reader will find a capital *résumé* of the state of affairs up to the present time. Stereoscopic work is next dealt with, and in the twenty-seven pages in which this subject is treated many useful hints will be found. Nearly the same amount of space is confined to some useful notes on development, including time, tank, and thermo methods. Practically the remainder of the book is taken up by the figures, facts, and formulæ, which always form the chief feature of this book.

Being well up-to-date and in a handy form the book should continue its useful career.

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 Ratio between Uranium and Radium in Minerals.

IN his interesting letter (NATURE, August 25) Mr. A. S. Russell describes the result of a determination of the amount of radium in a specimen of autunite from Autun, France, made by him in Prof. Marckwald's laboratory, which he found to be only 27 per cent. of the equilibrium amount. The ratio found by Mlle. Gleditsch in Mme. Curie's laboratory for the same mineral was 80 per cent., while Miss Pirret and I recently, for an autunite from Guarda, Portugal, found 44 per cent. Some results I have obtained since the paper with Miss Pirret was published appear to put a new complexion on the matter. Dual measurements of the radium ratio and of the helium content of several specimens of Portuguese autunite have shown that both vary considerably for different specimens of the same mineral. Prof. Piutti ("Helium in Recent Minerals," *Le Radium*, 1910, vii., 178) found that autunite was the only radio-active mineral in which helium could not be detected.

With a very delicate method, similar to that described for the detection of the helium produced from uranium and thorium (*Phil. Mag.*, August, 1908), I have only failed to find helium in one specimen of autunite, while in another the amount was such that Prof. Piutti would have detected it easily. The latter case refers to the specimen for which Miss Pirret and I found 44 per cent. for the radium ratio. The amount of helium was 3·3 cu. mm. per gram of uranium. On the assumptions, which certainly are not true but may not lead to an entirely false result, that the uranium was initially free from all products, and these have been all retained by the mineral, the age of the mineral would be 77,000 years and the period of average life of the parent of radium 132,000 years. The material was, however, not a single piece, a batch of

specimens containing 40 per cent. of autunite, obtained direct from the mining syndicate, having been ground up together. From a fresh batch, obtained through a dealer, two single pieces were picked out, the first being an almost pure crystal weighing 2·3 grams, and of so fresh and new appearance that it looked as if it had been withdrawn from its mother-liquor but yesterday, and the second an obviously older looking, greener, and much larger mass containing 46 per cent. of matrix. The first gave a radium ratio of 70 per cent., and in it helium could not be detected. The quantity was not greater than 0·002 cu. mm. per gram U. This quantity would form in about thirty years! For the second, the radium ratio was 44 per cent. and the helium 0·035 cu. mm. per gram U, which would be produced in about 600 years. Lastly, Mr. Russell very kindly gave me the remains of the specimen for which he found 27 per cent. for the radium ratio. It weighed less than 0·5 gram, but the helium was easily detectable. It amounted to more than 0·15 cu. mm. per gram U, some being lost.

If these results are representative, the radium ratio decreases to a minimum and then rises more slowly as the helium content increases. If the latter is taken as a measure of the age of the mineral, the minimum appears to be reached after a few thousand years. This, of course, is exactly what would occur if, when the autunite was formed, the radium (but not its parent) associated with the uranium in its former condition separated with the latter. This in itself is not only possible, but probable, owing to the isomorphism of radium and calcium. But it is a somewhat startling result if initial radium can have any influence on the amount present in a mineral to-day, for this necessitates that the ages indicated by the helium content are not altogether below the truth, and that these beautiful crystals are actually even now in full process of formation.

FREDERICK SODDY.

Physical Chemistry Laboratory, University of Glasgow.

Stagnant Glaciers

IN the notice of the Professional Papers of the U.S. Geological Survey on the "Glaciers, Goldfields, and Landslides of North America," published in NATURE of July 21, attention is directed to the peculiar stagnant condition of some glaciers, and to the fact that certain glaciers, after being stagnant for long intervals, suddenly commence to move.

Although the movement of glaciers is such as would take place if they were viscous bodies, there is reason to believe that they have not all the same viscosity. I pointed out in a paper communicated to the Royal Society (Proc. Roy. Soc., 1908, p. 250) that the calculated viscosities of several Swiss glaciers varied from $292{\cdot}2\times10^{12}$ to $3{\cdot}17\times10^{12}$ C.G.S. units. Although some of the data upon which these figures were based were only estimated ones, I do not think that the different viscosities found are due wholly to errors in the data. In other words, that the viscosity of glacier ice is not a constant, as in the case of water, &c., but varies with variations in the granular structure of the ice, or that there is a limiting stress below which distortion does not take place as with plastic bodies.

So far as I am aware, no glaciers have been proved actually to be stagnant by careful measurement. Generally speaking, the conclusion that a glacier is dead is formed owing to the absence of certain features which are generally associated with glacier movement.

It is very desirable that such statements should be based upon actual measurements only, and also that the actual granular structure of the ice should be given, for there is every reason to believe that the viscosity of glacier ice varies with the size of the glacier grains. Were it not for the fact that the glacier grains are actually broken up by shear planes in the ice, they would gradually become larger and larger until they became so large, and the viscosity became so great, that the ice would scarcely move at all on small slopes. In such a case an earthquake might give rise to fractures in the ice, and by temporarily decreasing the viscosity increase the rate of flow.

R. M. DEELEY.

Melbourne House, Osmaston Road, Derby, July 23.

IT chanced, strangely enough, that Mr. Deeley's interesting letter reached me at a Norwegian port during the return journey of the Geological Congress party from Spitsbergen, on which Prof. R. S. Tarr, whose work has given rise to the letter, is a fellow-traveller with me. I have therefore taken advantage of the opportunity to discuss the subject with Prof. Tarr and other glacialists of our party.

Mr. Deeley is right in his supposition that the stagnant condition of the "dead ice" in Alaska has been inferred from surface indications, and has not yet been tested by actual measurement. It is, indeed, not likely that the ice of the areas described as "stagnant" is absolutely motionless, nor do I think that this has been implied in the descriptions. Such motion as it may have must however be very small, since it seems that the trees covering parts of the surface-moraines in the "dead" areas show no sign of disturbance.

As hinted in my review, it is evident that rapid advances of glaciers, comparable to those observed in Alaska, have taken place in regions where some other cause than an earthquake must be sought. During our recent journey in Spitsbergen, of which I hope shortly to give some account in these pages, we have been shown by our leader, Prof. G. de Geer, several cases of this kind which he has studied. It may be that Mr. Deeley's explanation of ice-structure will explain these rapid spasmodic movements, but I shall not venture upon a discussion of this difficult physical question. Mr. Deeley has at any rate suggested a line of research which ought to be followed up and experimentally tested in the field.

Stockholm, August 19. G. W. LAMPLUGH.

The Leaning Tower of Pisa.

THE photograph of the "Leaning" Tower of Pisa in NATURE of August 4 shows clearly that the top tier is not square with the rest. From a rough alignment with the edge of a postcard, the photograph appears as if the tower was of the order of 25 mm./metre out of plumb when the top tier was put on presumably plumb.

Exact measures of this and of other parts of the tower might afford interesting data as to the epochs of the construction of the tower and of the progress of its "leaning."

EDWARD G. BROWN.

THIS famous tower will doubtless always be a question, like the man in the iron mask and other historical mysteries. Most architects, however, will be very slow to believe that it would have been built intentionally leaning on the general grounds that, however adventurous the architect, the clients would not have stood it. The analogy of the leaning towers of Bologna is hardly a sound one, as these plain shafts of brickwork, much like tall chimneys, can hardly be other than cases of settlement due to indifferent foundations. It should be remembered that construction was not a strong point with the Italians in the Middle and Renaissance Ages. In the case of the Tower of Pisa, Taylor particularly remarks on the wedge-shaped courses, which show an attempt to straighten the shaft. The best explanation appears to be that the tower was commenced, settled on its marshy bed, and that when the building was continued after a long interval it was considered safe to continue the work up to the limit of stability which could be calculated by the mathematicians of the epoch. The overhang is given by Taylor as 13 feet.

It is rather a pity that so much attention is concentrated by visitors on the tower, whereas the cathedral, Campo Santo, and particularly the Baptistery, are monuments of greater architectural importance. The design of the Baptistery is extremely interesting, and is perhaps the nearest expression of a Gothic dome.

The construction in this case is highly interesting, because the outer dome is supported by a cone, as at St. Paul's, London, but without an inner dome. As, however, the cone is not illuminated from the inside, it has a domical effect. The top of the cone shows externally, to the detriment of the general outline, not being cut off to carry a lantern as at St. Paul's.

Sir Christopher Wren may have known from travellers or by converse with foreign men of science of this example, but it is not necessary to jump to that conclusion, as an ordinary brick kiln or oast house would give the idea, aided by Wren's mathematical analysis of cones as units of high carrying power.

Taylor and Cresy's drawings of the Pisan monuments have every appearance of being most trustworthy, and should be consulted by your correspondent. I had the plates with me when visiting Pisa in 1890, and I had the opportunity to go up the tower and round its galleries. Ruskin has a passage on the setting out of the lower part of the western façade of the cathedral, but I remember the impression produced by my examination was not favourable to his argument.

ARTHUR T. BOLTON.

Victoria Mansions, 28 Victoria Street,
Westminster, S.W.

The Origin of the Domestic "Blotched" Tabby Cat.

THE question of the origin of the two types of our domestic cats has been the subject of much controversy, and it is therefore with diffidence that the views here expressed are now put forward. It is, of course, well known that any domestic "tabby" can, at a glance, be assigned to one of the two colour patterns, "striped" or "blotched."

In a recent paper (Proc. Zool. Soc., 1907, pp. 143–66) Mr. R. I. Pocock comes to the conclusion that the origin of *F. catus* (blotched tabby) is "at present quite unknown," and suggests that it is "the survivor of some extinct, probably Pleistocene, cat of Western Europe" (*ibid.*, p. 160); in effect, he regards *catus* as a good species. It seems to have been pretty clearly shown by the same writer that the *torquata* breed (striped tabby) is either the direct descendant of *F. sylvestris* or is the result of a cross between that species and *F. ocreata* (Proc. Zool. Soc., 1907, p. 947, and NATURE, vol. lxxvii., p. 414), which latter is, no doubt, merely a geographical race of *sylvestris*.

In his previous paper (Proc. Zool. Soc., 1907, p. 160) Mr. Pocock remarks that "when two distinct species cross the hybrid sometimes reverts in some respects to the characters of a [supposed] common ancestor of both"; this cannot be denied, but such a cross more commonly results in a form intermediate between the two parents, usually designated as a mongrel. After much diligent search, I have been unable to find a single instance in which complete segregation has taken place in respect of all specific characters *when two well-defined species are crossed.*

The two "types" of tabby, when crossed, always produce individuals which are at once referable to one or the other variety; in short, we get complete (Mendelian) segregation in respect of this character.

It therefore seems to me to be incompatible with the above observed facts, that *F. catus* is the survivor of some extinct cat of Western Europe, for if *catus* were a good species, when crossed with *torquata* we would most certainly have some form of intermediate produced. This, as we know from everyday experience, is contrary to the expressed results of such a cross. From these facts it is suggested as a possible explanation that *F. catus* arose *per saltum* from *F. sylvestris*. In short, I believe that *F. catus* has arisen from *F. sylvestris* as a "sport," and when crossed with its parent species or *inter se* follows the Mendelian law of segregation, as many such discontinuous variations have now been proved to do. At the same time (from evidence which cannot be here brought forward), it would appear that only in extremely rare cases, if at all, can Mendelian action be accountable for the evolution of a species *in nature*.

In opposition to such an origin, Mr. Pocock urges (Proc. Zool. Soc., 1907, p. 160) "the complete absence of evidence that species of Felis are ever dimorphic in pattern, and the ascertained fact that they breed true to their specific and sub-specific type." The objection, of course, is a purely negative one, and there is some evidence to show that animals under domestication are more subject to pronounced variation than in a state of nature.

In the leopard (*F. pardus*) we have a species of *felis* which can most certainly be regarded as dimorphic, in that it produces a black form, and (so far as the somewhat meagre information on the subject goes) in its gametic behaviour is exactly comparable to the case of the "blotched" and "striped" tabby. There are, so far as I know, no data in the case to show which is the "dominant" form, but, from analogy, it is almost certain the black would be dominant over the spotted. It is the hope of obtaining such information in the case of our common cats which has induced me to approach the subject. Finally, it may be said that, although no *direct* proof can be brought forward in support of such a suggestion, I am convinced that a properly conducted series of experiments with the two types would bring to light much evidence in favour of such a view.

Unfortunately, the writer is at present unable to carry out such a series of experiments, and it is hoped that others may hereby be induced to do so.

H. M. VICKERS.

81A Princes Street, Edinburgh, August 20.

I AM glad Mr. Vickers has directed the attention of Mendelians to the question of our two types of "tabby" cat. With the same purpose in view, and in the hope of inducing someone with time and facilities at his disposal to carry out breeding experiments with these animals, I recently communicated to the Mendel Society a paper on this subject, which will appear in the forthcoming issue of the journal. The results of such experiments are sure to be interesting, but whether or not they will settle the origin of the "blotched" tabby is another matter. They may turn the balance of the evidence in favour of this or that theory, but it is doubtful if they will result in more than a hypothetical conclusion. For myself I have quite an open mind on the point. As stated in my original paper on English cats, the "blotched" tabby may be regarded provisionally either as a survivor of some extinct cat that formerly inhabited Europe or as a "mutation" of the "striped" tabby. I reserved the names "*catus*" and "*torquata*" for these two types as a convenient means of designating them, following Linnæus's method, which is still in vogue, of assigning a specific epithet to our domesticated animals, like *Ovis aries*, *Canis familiaris*, and others, when their origin is uncertain or unknown.

I think Mr. Vickers a little overstates the case when he says there has been much controversy on the subject of the origin of these cats, and speaks of their existence as well known. It was the fact that the remarkable differences between them had been practically ignored or unappreciated by zoologists that induced me to discuss the question at some length three years ago. Nor do I think Mr. Vickers himself quite appreciates the distinction I emphasised between dimorphism in pattern and dimorphism in colour. Experience with wild animals shows that pattern is far more stable than colour. Pattern is wonderfully persistent; colour is not. No one would be greatly surprised at finding a black or white example in a litter of spotted hyænas, but it would be admittedly an extremely remarkable thing if a specimen resembling a striped hyæna in pattern occurred amongst them. Such a "mutation" would be comparable to the "mutation," if mutation it be, of the "blotched" from the "striped" tabby cat. Such a mutation in pattern as that supposed in the case of the hyæna may, of course, be produced to-morrow; but, so far as I am aware, no such variation has as yet been recorded, and I write this with full recollection of the curious variations in pattern that have been recorded of the common leopard.

Finally, may I demur to one more statement made by Mr. Vickers, namely, that animals under domestication are more subject to pronounced variation than those in a state of nature? I do not dispute this common assumption, but I am not satisfied that the evidence in its favour amounts to very much.

The questions raised by Mr. Vickers are, however, full of interest; and all that I have said is in justification of the agnostic attitude that I think should be, for the present, preserved towards the origin of the "blotched" tabby cat.

R. I. POCOCK.

Zoological Gardens, August 24.

LAKE BALATON.[1]

LAKE BALATON, or Platten See, is the largest lake in Austro-Hungary, and, in fact, in south-eastern Europe. It is fifty miles long, and is shallow in proportion to its size. It lies in a depression on the Hungarian plain at the foot of the hills of the Bakony Wald. The Hungarian Geographical Society organised a commission, under the presidency of Prof. Ludwig von Loczy, to subject this lake to a thorough investigation. The results are being published in three volumes, of which the first is devoted to geography, geology, palæontology, hydrography, physics, and chemistry; the second to biology; the third to the social and ethnographical geography, including accounts of the watering-places and hot springs, and a bibliography. Four further sections of this work have now been received, and one of them completes the second volume. As the parts are issued in the order of their completion, it is not easy to form from these disconnected fragments a clear impression of the work as a whole. Thus the only contribution yet issued to the introduction, which is to be a geographical memoir on the lake and its district, is a geo-physical appendix, dealing with the determination of gravity by R. von Sterneck, with the influence of variations in gravity on the level of the lake surface by Baron Lorand Eötvös, and a report on the magnetic observations by Dr. L. Steiner. Dr. von Sterneck's results show that gravity is normal over part of the middle of the lake, while it is above normal along a belt of the hills to the north, and it is below normal in a band still further to the north.

Baron Eötvös has determined the relations of the variations in gravity to the level of the lake surface by measurements made on the ice during the winter. His observations were interrupted by the mild winter of 1902, when the lake was inadequately frozen. His results show that Lake Balaton occurs along a tectonic line, and he recognises variations in level due to gravity, similar to those in India, but on a smaller scale. Dr. Steiner has determined the various magnetic elements for the area of the lake, and has investigated the magnetic properties of the rocks.

No other locality in Europe is so convenient for the study of the formation of wide ice-sheets on an inland sea as Lake Balaton, for, in spite of the comparative saltness of the water, its surface is more completely frozen than the Swiss lakes, which being much deeper, therefore cool more slowly. In ordinary winters the whole of Lake Balaton is covered over with a firm ice-sheet. Dr. von Cholnoky has made a detailed study of the ice in all stages of its formation and decay, illustrated by numerous excellent photographs. The ice-sheet is broken into separate floes separated by narrow leads, which are locally known as rianas, and the wind, driving the ice-fields together or against the shore, piles it into ice-hummocks, which on Lake Balaton are known as turolas. Many of the features of the Arctic ice-sheets are found repeated in southern Europe. Dr. Cholnoky, following Buckley and van Hise, draws an interesting comparison between the movements of the ice-sheet and the earth's crust. Blocks of the ice founder, forming areas of subsidence, and long strips sink between parallel faults forming rift valleys separated by horsts, while various overthrust faults are found in the pressure ridges.

FIG. 1.—Hummock formed from fresh ice on Lake Balaton, January 23, 1903.

The volume on the biology of Lake Balaton is now completed by a memoir on the attempts to acclimatise various tropical water-lilies in the Hévizsee, a well-known bathing resort near Keszthely, to the north of the western end of Lake Balaton. This lake is about three hundred yards across, and is fed by hot

[1] "Resultate der Wissenschaftlichen Untersuchungen des Balaton." Vol. i., Physische Geographie des Balatonsees und seiner Umgebung: Part i., Die Geomorphologie des Balatonsees und seiner Umgebung, Section iii., Geophysikalischer Anhang i. (I.) R. v. Sterneck, Untersuchungen über die Schwerkraft, pp. 31, 1 map; (II.) Baron L. Eötvös, Die Niveaufläche des Balatonsees und die Veränderungen der Schwerkraft auf diesem, pp. 61, 27 figs.; (III.) L. Steiner, Erdmagnetische Messungen in Sommer 1901, pp. 30, 6 figs. Price 6 kroner. Part v., Die Physikalischen Verhältnisse des Wassers des Balatonsees: Section iv., E. v. Cholnoky, Das Eis Balatonsees, pp. 114, xxi. plates, 122 figs. Price 10 kroner. Vol. ii., Die Biologie des Balatonsees und seiner Umgebung: Part ii., Die Flora, Section ii., Die Pflanzengeographischen Verhältnisse der Balatonsee-gegend, appendix: A. Jovassy, Die Tropischen Nymphæen des Hévizsees bei Keszthely, pp. 100, iv. plates, 25 figs. Price 10 kroner. Vol. iii., Soziologische und Anthropologische Geographie der Umgebung des Balaton: Part i., Geschichte der Umgebung des Balaton, Division iii., R. Békefi, Kirchen und Burgen in der Umgebung des Balaton im Mittelalter, pp. 363, 1 map, 142 illustrations. Price 20 kroner.) Vienna: Ed. Hölzel, 1907-9.)

springs, so that the temperature of the water is from 32° to 38° C. in summer, and from 26° to 30° C. in winter. A chapter on the composition of the lake water, by G. v. Weszelszky, shows that it contains 0·531 part per thousand of salts, of which the chief are magnesium chloride, bicarbonate of lime, and sodium sulphate. The shape of the lake basin has been carefully determined by Dr. Jordan.

Dr. Lovassy has attempted to acclimatise tropical water-lilies in this pond. He points out the interesting fact that the Nile lotus (*Nymphaea lotus*) is still living in the warm waters of Nagyvared, and a flower stem referred to this plant was discovered in Upper Pliocene calcareous tufa at Ganocz, in Szepes, by Prof. Pax, of Breslau, in 1904. Dr. Lovassy, therefore, holds that the Nile lotus still lives in Hungary

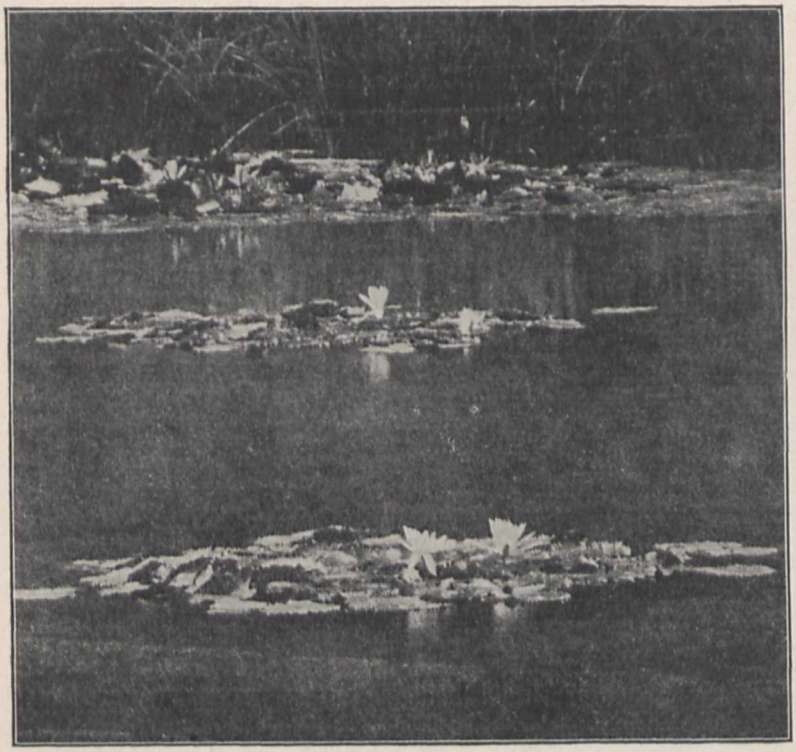


FIG 2.—Water-lilies in the Hévizsee. In foreground some specimens of *Nymphaea lotus*, L., and in background *Nymphaea rubra longiflora*, nov. subsp.

as a relic from its former wide extension over southern Europe. He insists that the plant was neither introduced by man nor birds, and that Nagyvared is a natural subtropical oasis. Earlier attempts to plant tropical water-lilies in the Hévizsee were made between 1826 and 1842. Dr. Lovassy's experiments lasted from 1898 to 1906, and were tried on many distinct species; and in connection with the work he has compiled a synopsis of the Nymphaceæ; some species failed altogether, others lived, but would not produce seeds, and only a variety of the Indian *Nymphaea rubra*, for which he founds a new subspecies, *longiflora*, has been successfully acclimatised.

The longest of the four contributions recently received is a memoir by Dr. Békefi on the mediæval churches and castles in the neighbourhood of Lake Balaton. It consists of a detailed account illustrated by plans and photographs, both of the buildings still occupied and those represented by numerous picturesque ruins. J. W. G.

THE BRITISH ASSOCIATION AT SHEFFIELD.

FROM the point of view of numbers, this year's meeting of the British Association, with a total membership of about 1400, does not take a very high place among the great meetings of recent years; nevertheless, there is only one opinion as to its success. The arrangements have been admirably made, and everyone agrees that no more perfect and convenient place for the reception-room and accessory writing and other rooms could have been provided than has been furnished at the Cutlers' Hall. The local committee, under the chairmanship of Prof. W. M. Hicks, is to be congratulated upon the businesslike way in which it has organised the many and various general affairs of the meeting. The scientific proceedings of the sections have been full of interest, but here no further reference need be made to them, as accounts of the work of the sections will appear in later issues.

The annual report of the council of the association was presented at the meeting of the general committee on August 31. The council presented an address to the King upon his accession to the throne, and in a further letter expressed the hope that he would follow his august father in the patronage of the association. This the King has consented to do.

At the Winnipeg meeting last year a resolution was formulated by the Anthropological Section, relating to inquiries into Canadian ethnology, was supported by the general committee, and referred to the council. This resolution, which was forwarded to the Dominion Government by the council was as follows :—

I. (1) "That it is essential to scientific knowledge of the early history of Canada that full and accurate records should be obtained of the physical character, geographical distribution and migrations, languages, social and political institutions, native arts, industries, and economic systems of the aboriginal peoples of the country.

(2) "That scientific knowledge of the principles of native design and handicraft is an essential preliminary to any development of native industries such as has already been found practicable, especially in the United States, in Mexico, and in India, and that such knowledge has also proved to be of material assistance in the creation of national schools of design among the white population.

(3) "That, in the rapid development of the country, the native population is inevitably losing its separate existence and characteristics.

(4) "That it is therefore of urgent importance to initiate, without delay, systematic observations and records of native physical types, languages, beliefs, and customs; and to provide for the preservation of a complete collection of examples of native arts and industries in some central institution, and for public guardianship of prehistoric monuments such as village sites, burial grounds, mounds, and rock carvings.

(5) "That the organisation necessary to secure these objects, and to render the results of these inquiries accessible to students and to the public, is such as might easily be provided in connection with the National Museum at Ottawa, which already includes many fine examples of aboriginal arts and manufactures, and might be made a

centre for the scientific study of the physical types, languages, beliefs, and customs of the aboriginal peoples."

II. To recommend the council to urge the Dominion Government to include in the schedules of the next Canadian census full inquiries as to precise place of origin, native language, previous status and occupation, year of immigration, and such other information as may be deemed of scientific value for the study of the effects of the Canadian environment upon immigrants of European origin.

The resolution was referred to the Canadian Geological Survey by the Privy Council, and in the course of a reply the director of the survey, Mr. R. W. Brock, stated that the Government had shown appreciation of the value of the work by enabling the survey three years ago to make a beginning in the direction indicated. An ethnologist is at present living with the Eskimo in the Arctic, and a preliminary report on his observations appeared in the Geological Survey summary report for 1908. With the assistance of the Canadian archæological societies and the support which the British Association gave in its resolution, the director expressed strong hopes that something worth while may be accomplished along these lines.

It was subsequently reported to the council by the general officers that information had reached them that the Dominion Government of Canada had authorised the payment of the salary of an ethnologist for the Dominion, and also a grant for the collection of ethnological material. This may be regarded as a direct outcome of the representations made by the British Association.

The important question of the relationship of the sections generally, and the possible desirability of a new subdivision and the incorporation of new subjects was referred to the council by the general committee at Winnipeg. A committee was appointed by the council to consider the matter, and among its recommendations were (1) that the title of Section A be changed to "Mathematics, Physics, and Astronomy (including Cosmical Physics)"; (2) that the question of the combination of geology and geography into one section of two departments should receive further consideration; (3) that there should be a permanent subsection of agriculture, attached to a particular section annually, such as chemistry, economic science, and botany. The proposed changes did not, however, meet with the approval of the general committee. It was resolved at the meeting of this committee on September 2 that the present title of Section A should remain unaltered, that Sections C and E should not be combined, and that the question of the sub-section of agriculture should be referred back to the council.

Sir William Ramsay was nominated by the council to fill the office of president of the association for next year's meeting at Portsmouth, and his nomination was confirmed by the general committee. At the meeting of this committee on September 2 an invitation from Dundee to visit that city in 1912 was unaimously accepted. An invitation to meet in the capital cities of Australia was conveyed by Sir George Reid, High Commissioner of the Commonwealth, and Prof. Orme Masson. The proposal was that the association should spend a few days each in Adelaide, Melbourne, Sydney, and Brisbane. The general committee was informed that the Commonwealth Government has voted 10,000*l.*, which is earmarked for oversea expenses, and that the contributions of the several States will include free railway travelling. The minimum time needed for the visit, including the journey out and home, will be about three months. After discussion, it was proposed by Sir William Ramsay that the invitation should be accepted for 1914. The resolution was seconded by Prof. H. B. Dixon and carried by the general committee.

On Tuesday afternoon a special degree congregation was held at the University, when the Duke of Norfolk, as Chancellor of the University, conferred honorary degrees upon the following distinguished visitors and two leading Sheffield men—the Lord Mayor (Earl Fitzwilliam) and Sir Joseph Jonas:—LL.D.: The Right Hon. the Lord Mayor of Sheffield (Earl Fitzwilliam). D.Sc.: Mr. W. Bateson, F.R.S., Prof. T. G. Bonney, F.R.S., Sir William Crookes, F.R.S., Mr. Francis Darwin, F.R.S., Prof. T. W. Rhys Davids, Sir Archibald Geikie, K.C.B., F.R.S., Prof. E. W. Hobson, F.R.S., Sir Oliver Lodge, F.R.S., Sir Norman Lockyer, K.C.B., F.R.S., Dr. H. A. Miers, F.R.S., Sir William Ramsay, K.C.B., F.R.S., Prof. C. S. Sherrington, F.R.S., Sir J. J. Thomson, F.R.S. D.Eng.: Sir Joseph Jonas, J.P., Sir W. H. White, K.C.B., F.R.S. D.Met.: Mr. J. E. Stead, F.R.S.

Subjoined is a synopsis of grants of money appropriated for scientific purposes at the Sheffield meeting:

Section A.—Mathematical and Physical Science.

	£
Turner, Prof. H. H.—Seismological Observations	60
Shaw, Dr. W. N.—Upper Atmosphere	25
Preece, Sir W. H.—Magnetic Observations at Falmouth	25
Gill, Sir David.—Establishing a Solar Observatory in Australia	50
Gill, Sir David.—Grant to the International Commission on Physical and Chemical Constants	30

Section B.—Chemistry.

Divers, Prof. E.—Study of Hydro-aromatic Substances	20
Armstrong, Prof. H. E.—Dynamic Isomerism	25
Kipping, Prof. F. S.—Transformation of Aromatic Nitroamines	15
Kipping, Prof. F. S.—Electro-analysis	15
Arnold, Prof. J. O.—Influence of Carbon, &c., on Corrosion of Steel	15

Section C.—Geology.

Harker, Dr. A.—Crystalline Rocks of Anglesey	2
Tiddeman, R. H.—Erratic Blocks	10
Lapworth, Prof. C.—Palæozoic Rocks	10
Watts, Prof. W. W.—Composition of Charnwood Rocks	2
Watts, Prof. W. W.—Igneous and Associated Sedimentary Rocks of Glensaul	15
Bourne, Prof. G. C.—Mammalian Fauna in Miocene Deposits, Bugti Hills, Baluchistan	45

Section D.—Zoology.

Woodward, Dr. H.—Index Animalium	75
Hickson, Prof. S. J.—Table at the Zoological Station at Naples	75
Shipley, Dr. A. E.—Feeding Habits of British Birds	5
Shipley, Dr. A. E.—Belmullet Whaling Station	30
Bourne, Prof. G. C.—Mammalian Fauna in Miocene Deposits, Bugti Hills, Baluchistan	30

Section E.—Geography.

Chisholm, G. G.—Map of Prince Charles Foreland	30
Herbertson, Prof. A. J.—Equal Area Maps	20

Section F.—Economic Science and Statistics.

Cannan, Prof. E.—Amount and Distribution of Income	5

Section G.—Engineering.

Preece, Sir W. H.—Gaseous Explosions	90

Section H.—Anthropology.

Munro, Dr. R.—Glastonbury Lake Village	5
Myres, Prof. J. L.—Excavations on Roman Sites in Britain	10
Read, C. H.—Age of Stone Circles	30
Read, C. H.—Anthropological Notes and Queries	40
Munro, Dr. R.—Artificial Islands in Highland Lochs	10

Section I.—Physiology.

Schäfer, Prof. E. A.—The Ductless Glands	40
Sherrington, Prof. C. S.—Body Metabolism in Cancer	6

	£
Hickson, Prof. S. J.—Table at the Zoological Station at Naples	25
Waller, Prof. A. D.—Electromotive Phenomena in Plants	10
Waller, Prof. A. D.—Anæsthetics	20
Sherrington, Prof. C. S.—Mental and Muscular Fatigue	25
Starling, Prof. E. H.—Dissociation of Oxy-hæmoglobin	25
Section K.—Botany.	
Scott, Dr. D. H.—Structure of Fossil Plants	15
Darwin, Dr. F.—Experimental Study of Heredity	45
Johnson, Prof. T.—Survey of Clare Island	20
Oliver, Prof. F. W.—Registration of Botanical Photographs	10
Section L.—Education.	
Findlay, Prof. J. J.—Mental and Physical Factors	10
Corresponding Societies Committee.	
Whitaker, W.—For Preparation of Report	20
Total	1090

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY J. E. STEAD, F.R.S., F.I.C., F.C.S., PRESIDENT OF THE SECTION.

IT was with considerable diffidence that I accepted the position of President of this section. The long list of illustrious and eminent chemists who have occupied the chair in the past, men of science of the highest attainments, and usually professors of our educational institutions, is indicative of the very high standard to be followed. As, however, it was urged that a President with experience in the metallurgy of iron and steel was desired, I bowed to the decision of the Council, concluding that even as a mere layman I might, in this address, discuss one or more subjects to which prominent metallurgists have for the past thirty years directed their earnest attention, both in Europe and America. I refer to some of the underlying phenomena connected with the effect of sulphur and silicon on the carbon condition of commercial cast iron.

The effect of sulphur and silicon on cast iron has received the attention of Karsten, Percy, Weston, Howe, Keep, West, Dillner, Bachman, Summershach, Wüst, Johnson, Stoughton, Hailstone, Longmuir, Adamson, Turner and Schuler, Levy, and many others. They all agree in concluding that sulphur tends to make iron white by retaining the carbon in the combined state, and that silicon tends in the opposite direction. Prof. Howe and Dr. Wüst have endeavoured to arrive at the exact quantitative effect of sulphur and silicon in preventing or facilitating the decomposition of the carbides.

Howe recognised that the data available are insufficient on which to make any final conclusion.

Wüst found, by a series of trials, that in pigs containing 3·15 per cent. carbon and about 1 per cent. silicon, on an average 0·01 per cent. sulphur prevented the separation of 0·02 per cent. graphite, but that with 2 per cent. silicon its effect was much less.

It is the general experience, that the effect of sulphur depends on the proportion, not only of silicon, but of the total carbon and manganese, and of the temperature at which the iron is cast, and the size and temperature of the mould into which the metal is run. Under some critical conditions 0·1 per cent. sulphur may prevent the separation of 3 per cent. graphite.

Howe's discovery—that the tendency of silicon, in increasing the decomposition of the carbides, is rapid at first, especially as the silicon rises from zero to 0·75 per cent., and then slower and slower with each further increase—is very important; so also is the generalisation of Messrs. Charpy and Grenet—that the separation of graphite on annealing iron which is initially white, containing the whole of the carbon in the combined condition, begins at a temperature which is the lower the greater the percentage of the associated silicon, and that the separation of graphite, once begun, continues at even lower temperatures than that at which it started.

The evidence advanced by Phillips, Prost, Campredon, Schulte, and others—that, on dissolving sulphurous irons in hydrochloric acid, all the sulphur is not given off as H_2S, and that a part either passes off as $S(CH_3)_2$ or remains behind with the solution as some organic product—was tentatively believed as indicative that the sulphur is chemically associated with the carbon and the iron.

Levy,[1] who has done much good work in the endeavour to determine the relations which exist between iron, carbon, and sulphur, in the alloys of these elements, states, as the result of his research, that there is no conclusive evidence of any chemical union.

In his tabulated results showing the amount of sulphur evolved presumably as $S(CH_3)_2$ on dissolving iron, carbon and sulphur alloys, the maximum is 0·06 per cent., but the average is very much less.

Schulte, on the other hand, had found that from 1 per cent. to 12 per cent. of the total sulphur is evolved as an organic sulphur compound; and Bischoff found an even greater quantity.

The results are apparently conflicting, and it is evidently obvious that more research is required in this direction.

It has been shown by Arnold and McWilliam, and confirmed by others, that carbide of iron does not decompose into graphite and iron during the annealing of steel until it segregates into relatively large masses. Taking this as a basis, Mr. Levy has advanced an explanatory hypothesis as to how it is that sulphide of iron prevents the decomposition of carbides in white irons. He had found that during the solidification of irons free from silicon and manganese, but rich in sulphur, "the sulphide separates at a temperature in the neighbourhood of 1130° C., together with, and as a component of, the austenite-cementite eutectic, forming a triple austenite-cementite-sulphide eutectic, the cementite component of which is interstratified with a jointed pearlite (by decomposition of austenite) sulphide one." He stated that "The presence of iron sulphide in the eutectic introduces intervening layers, which may partly ball up on annealing, but even then leave sulphide films between the cementite crystals; these act almost as emulsifiers, preventing the coalescence of the cementite portion, which is apparently a necessary preliminary to its decomposition into free carbon and iron. These layers and films are so persistent, even on slow cooling, as to retain their position between the cementite crystals, until the metal has cooled well below the temperature of decomposition, so that an iron which might otherwise become grey is retained, even on very protracted cooling, in the white form, by sulphur as sulphide; 0·25 per cent. sulphur being sufficient for this purpose under the moderately protracted cooling conditions of the research. It is not improbable that the mechanical force exerted by sulphide, on separation and cooling, may also prevent the physical conditions necessary for carbide decomposition, which, as is well known, is accompanied by considerable expansion."

It is to be noted that Mr. Levy's argument is based on the effect of the sulphide films in the eutectic, preventing the segregation of the cementite into relatively large masses, which, as he expresses it, "is apparently a necessary preliminary to its decomposition."

His conclusions were based on the examination of hypo-eutectic alloys containing not more than 2·75 per cent. carbon and free from massive plates of cementite.

Whilst admitting that his conclusions may be correct, as applied to the eutectic, some other explanation would be necessary if decomposition did not occur when a considerable quantity of massive cementite initially were to form in the alloy.

That stable massive cementite can be so obtained in iron sulphide alloys I shall presently show.

If it could be shown that sulphur in some form of combination with the iron and carbon does crystallise with the carbides, and that such mixture or solid solution is stable and not readily decomposed, it would be reasonable to conclude that the sulphur is responsible for the stability.

It has been suggested that silicon in iron decomposes the carbides according to the following chemical reaction: $3Si - {}^2Fe_3C = {}^3Fe_2Si - 2C$. The only objection to this explanation is that the silicon is not free in cast iron, as was

[1] "Journal of the Iron and Steel Institute," No. 2, 1908.

proved by Turner, and, moreover, as will be shown presently, it is combined with iron in solid solution before the carbide is decomposed.

Gontermann [1] found that on adding pure silicon to molten iron, the iron and silicon combined with considerable rise in temperature, and I have noticed the same thing even when adding it to carburised iron.

The same authority, who has made a most careful study of the ternary alloys of the iron-carbon-silicon series, has shown that the eutectic freezing-point rises with the silicon from 1130° when silicon is absent, to about 1150° when it reaches 10 per cent., and to 1175° when it is about 17 per cent., and that the carbon in the eutectic of the alloys containing between 0 per cent. and 10 per cent. silicon, falls as the silicon rises by about 0·3 per cent. for each unit of silicon.

The same author proved that the pearlite reversion point in these alloys rises with the silicon on an average of about 30° C. for each unit of silicon in the alloys containing between 0° and 6 per cent. silicon. He concluded, but did not actually prove, that in the region of the curve of unvarying equilibrium two cementites crystallise; one a solid solution of the carbide and silicide of iron; and a second, a mixture of this with another ternary iron-silicon-carbon solid solution.

If the composition of the alloy lies between the curve of saturated silico-austenite and the curve of non-varying equilibrium, saturated silico-austenite primarily forms; and following this a secondary crystallisation of a binary eutectic consisting of this saturated austenite and silico-cementite.

In the year 1901 I described certain unique idiomorphic crystals which had been found in the hearth of a disused blast furnace at Blaina. The crystals were more or less oxidised on their exterior surfaces.

The analysis was as follows:—

	After deducting the Oxygen, &c. Per cent.
Manganese	54·56
Iron	37·71
Carbon	3·91
Silicon	3·82
	100·00

A micro-examination proved the crystals to be quite homogeneous mixtures, or solid solutions. It was difficult to assign to them any definite chemical constitution. They may be considered as silico-carbides of manganese and iron, and, as will be shown presently, bear a close relation to similar crystals which primarily form during the freezing of iron-carbon-silicon alloys.

Having briefly referred to the work of a number of authorities, I now propose to describe my attempts to supplement our knowledge in this direction by a purely micro-chemical research.

In order to understand the remarks which follow, it is necessary briefly to describe the changes which occur when pure iron-iron carbide alloys pass from the liquid to the solid state as are indicated by the researcehs of Osmond, Roberts-Austen, Stansfield, and of Carpenter and Keeling.

In the iron alloys containing less than the eutectic proportion of 4·3 per cent. carbon, described as hypo-eutectic alloys, austenite octohedral crystallites of the fir-tree type first fall out of solution, and these continue to grow until the liquid is so impoverished of iron and enriched in carbon that when the eutectic proportion of 4·3 per cent. carbon is reached, the liquid solidifies and breaks up into carbide of iron and austenite.

The hypereutectic alloys, containing more than the eutectic proportion of carbon, on cooling, first yield carbide of iron crystals, and these continue to grow until, by removal of the excess carbon, the eutectic proportions of iron and carbon are reached. The eutectic in its turn then freezes.

For the purpose of my research it was necessary to select pig metals, grey and high in silicon and white with high sulphur. These were kindly supplied by Messrs. Wilson, Pease and Co. and Messrs. Cochrane and Co., Middlesbrough. They were made from Cleveland ironstone and contained:—

[1] "Anorganische Chemie, Bd. 59, 1908.

	White	Grey Glazed Iron No. 1	Grey Glazed Iron No. 2
	Per cent.	Per cent.	Per cent.
Combined carbon	2·98	nil	trace
Graphite	traces	2·65	3·300
Manganese	0·29	0·72	0·676
Silicon	1·89	5·21	4·321
Sulphur	0·27	0·03	0·025
Phosphorus	1·62	1·56	1·660

It may be accepted that the sulphur in the white iron undoubtedly is the cause of the whiteness of the iron, whilst the excessively high silicon and low sulphur are equally responsible for the graphitic condition of the carbon in the grey irons.

The micro-structure of the high silicon metal was characteristic of all phosphoretic, high-silicon, carbon alloys. Curved plates of graphite cut the mass in many directions, whilst the binary eutectic of phosphorus and iron remained in irregular patches, generally midway between the graphite plates. The ground mass occupying the space between the eutectic and graphite plates consisted of silico-ferrite.

The interesting feature about the structure of the white iron is that there was no iron-iron-carbide eutectic. This had been replaced by the ternary eutectic of iron-phosphorus and carbon, which, according to Dr. Wüst, contains about:—

	Per cent.
Iron	91
Phosphorus	7
Carbon	2
	100

There was evidence that the primary crystals of austenite of the octohedral skeleton type had been the first to fall

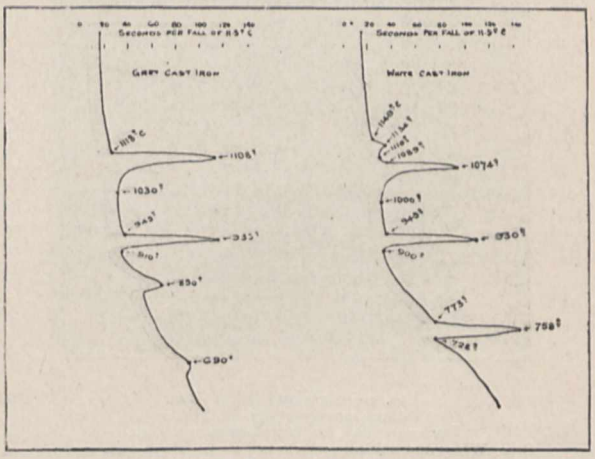


Diagram showing arrest in cooling; grey iron No. 2 on left, white iron on right.

out of solution, that the second crystal to form consisted of short plates of carbide of iron (cementite); whilst the ternary eutectic of phosphorus, carbon, and iron was the last to freeze and occupied spaces between the cementite plates and the primary crystals.

Dr. Carpenter and his assistant, Mr. Edwards, of Victoria University, Manchester, kindly obtained, for the purpose of this address, the cooling curves of these two typical metals. These were as follows:—

Grey Iron.

The long arrest at 1118° indicates a change of state, but is also coincident with important chemical changes. The second long arrest at 945° is due to freezing of the iron phosphorus carbon eutectic. The arrest at 850° indicates the formation of pearlite, and corresponds closely with the arrest in a similar alloy examined by Gontermann. The arrest at 690° is probably due to the formation of pearlite in the eutectic of iron and phosphorus, and is of great interest, for it points to the conclusion that silicon is not a constituent of the austenite of the ternary eutectic.

White Iron.

The micro-structure and analysis help more fully to explain the arrests on cooling this alloy.

The first arrest, at 1149° C., is where the primary austenite crystallises with the silicon, as will be shown presently.

The second arrest is where the primary cementite plates freeze.

The third arrest, at 945°, is the freezing point of the ternary eutectic, and is identical with that of the corresponding long arrest of the grey iron.

The fourth arrest, at 77°, is coincident with the formation of pearlite.

Bearing in mind that the manganese in the white iron was insufficient to combine with the whole of the sulphur present to form manganese sulphide, it is obvious that some other compound or compounds of sulphur existed. The microscope clearly revealed the presence of manganese sulphide and traces of free iron sulphide.

The carbide plates were quite free from striations of sulphide, such as had been noticed by Mr. Levy in the eutectic of high sulphur irons.

But for the sulphur present, the silicon would have been sufficient to effect a decomposition of the carbides, and the metal in absence of the sulphur would have given a

FIG. 1.—Cleveland White Iron.
White = massive plates of Fe_3C.
Dark = pearlite, the decomposed austenite.
White and half-tone = ternary Fe—C—P eutectic.

grey instead of a white fracture. In view of this conclusion, it appeared to be probable that if manganese were to be melted with the metal, it would combine with the sulphur associated with iron, &c., and crystallise as MnS, previous to the solidification of the carbide, or independently, and that the metal would then become grey on cooling.

In order to test this, a portion of the metal was melted in a clay pot with a little pure manganese, free from carbon—sufficient to give 1 per cent. of manganese, which was more than sufficient to combine with the whole of the sulphur. As soon as the mass was melted it was at once poured into a sand mould and allowed to set. When cold, it broke with a grey fracture corresponding to what is known as hard forge, and the combined carbon, instead of being about 3 per cent., was reduced to 0·6 per cent., a result proving the correctness of the hypothesis.

It is well known that when manganese or chromium and some other metals are present in large quantities in pig irons, these metals, as carbides, crystallise with the carbide of iron, forming double carbides, and these are much more stable than the massive pure iron carbide. It appeared reasonable to believe that if sulphide of iron, or some iron-sulpho-carbon compound, were to crystallise with the carbides it would have a similar effect.

Remembering that the conclusions on this question, as to whether sulphur does or does not crystallise with the carbides, are conflicting, it is evident that the only possible way to find out whether sulphur does so crystallise is to separate the carbide from the iron and test it for sulphur. With this object, a considerable quantity of the original Cleveland white metal was crushed to the very finest powder. It was then treated with a 10 per cent. solution of hydrochloric acid in water in large excess, and the action of the acid was allowed to continue until evolution of gas ceased. The insoluble matters, consisting mainly of carbides and phosphides, were filtered off, washed and dried, and were ground down in an agate mortar to a still finer powder, so as to liberate any mechanically entangled sulphides. The powder so dealt with was again treated with acid as before, after which the residue was filtered off, thoroughly washed with water, was transferred to a separate vessel, and was boiled with strong caustic-potash to dissolve any decomposition products.

The residue was again filtered off, was washed and dried, and submitted to analysis. The residue when dried weighed about 45 per cent. of the original metal, and contained as follows:—

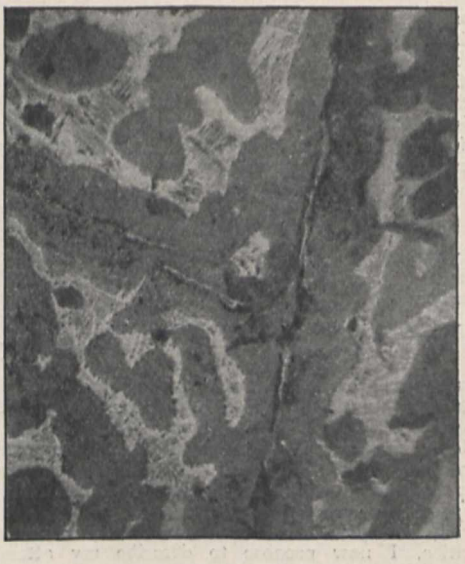


FIG. 2.—Cleveland Glazed Iron.
Ground mass = silico-ferrite.
White complex = iron—iron phosphide eutectic.
Straight dark lines = graphite.

	Per cent.
Iron	92·43
Carbon	6·06
Silicon	0·12
Sulphur	0·12
Phosphorus	0·97 (6·2 per cent. phosphide of iron)
Water, &c.	0·30
	100·00

A second trial was made with the same metal; but, in this case, repounding and acid treatment were repeated three times, so as to eliminate the possibility of mechanical inclusion of sulphide or iron. The sulphur found in the remaining carbides was 0·1 per cent.

As the manganese in this metal was not sufficient to form manganese sulphide with the sulphur, it seemed desirable to determine whether or not, when the manganese is in sufficient quantity, sulphur would crystallise with the carbide. For this purpose the white chilled part of a crushing roll was experimented upon. The centre part was open grey iron, and contained 3·1 per cent. of the carbon as graphite.

The white chilled portion contained:—

	Per cent.
Combined carbon	3·75
Graphitic carbon...	Trace
Manganese	0·65
Silicon	0·70
Sulphur	0·10
Phosphorus	0·23

It was crushed to powder and treated exactly in the same way as previously described for the separation of carbide. The residue contained by analysis :—

	Per cent.
Silicon	0·028
Sulphur	0·016

a result showing that only a minute quantity of sulphur was crystallised with the carbide. Whether a different result would follow if both sulphur and manganese were greatly increased has yet to be determined.

Having proved that sulphur in some undetermined state of chemical combination does crystallise with carbide of iron, an attempt was made to determine the maximum amount of that element the carbide will retain under the most favourable conditions. With this object in view, a considerable quantity of very pure white iron, containing only traces of silicon, sulphur, and phosphorus, and 3·5 per cent. of carbon, was melted in a plumbago crucible, and when in a molten condition sticks of roll sulphur were

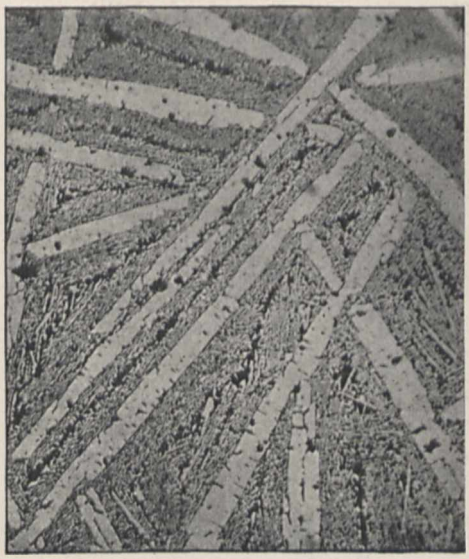


FIG. 3.—Iron-Carbon-Sulphur Alloy (4·37 per cent. Carbon).
White thick bands = massive carbide of iron.
Complex structure = iron—iron-carbide-sulphide-pearlite eutectic.

forced under the surface of the metal, and afterwards the mixture was briskly shaken up with the sulphur which had liquefied on the surface.

Precisely the same result was obtained as described by Karsten, who had made a similar experiment. A metal was produced having a white fracture and large cleavage faces. The micro-structure was similar to that of hyper-eutectic iron carbon alloys. Large plates of carbide cut the metal in many directions, whilst between the carbide plates was located the triple carbide-sulphide-pearlite eutectic, so accurately described by Mr. Donald Levy.

The carbide plates themselves were peculiar in having circular prismatic inclusions of sulphide of iron symmetrically arranged at right angles to the sides of the plates. In horizontal sections of these plates they appeared as circular dots, sometimes arranged in continuous lines, suggesting that the sulphide had been actually in solution with the carbide when the metal was liquid, that they fell out of solution together, the sulphide separating and segregating along the cleavages of the carbide.

A portion of this sulphurous material was remelted and treated with a second quantity of sulphur. This time, in addition to sulphide of iron, a considerable quantity of the soot-like substance described by Karsten floated to the surface, and free graphite separated and stuck to the sides of the crucible.

The analyses of these metals are as follows :—

	After the first addition of Sulphur Per cent.	After the second treatment with Sulphur Per cent.
Carbon	4·37	4·39
Sulphur ...	about 1 00	1·00
Silicon...	0·03	0 05

From which we may conclude that the maximum degree to which the carbon can be concentrated by this method is about 4·4 per cent. In these trials the carbide certainly had sufficient opportunity to become saturated with sulphur in each case. Both of the metals were crushed to exceedingly fine powder, and were treated with acid to decompose the free sulphides. The residues were repounded and treated with acid a second time, and afterwards with strong potash solution. After this treatment, analyses of the insoluble residues indicated in one case 0·09 per cent. sulphur, and in the other 0·08 per cent. *From this it would appear that carbides will not carry in solid solution more than about 0·1 per cent. of sulphur.*

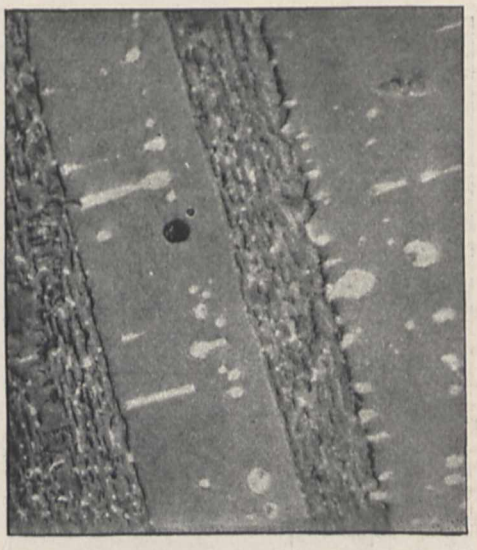


FIG. 4.—Same as Fig. 2, heat-tinted and more highly magnified.
Broad bands = massive carbide of iron with inclusion of sulphide of iron.
Complex structure = jointed eutectic of Fe—Fe_3C—FeS.
The white specks are all FeS.

The metal containing 4·37 per cent. carbon and 1 per cent. sulphur, even on prolonged annealing, did not become graphite, a proof that the massive carbides present were quite stable.

The microscope reveals the fact that in almost all commercial white irons containing much sulphur the greater part of the sulphur is combined with either manganese or iron, and that the sulphides mainly exist as independent inclusions. It appears reasonable to assume that the manganese sulphide is without influence on the carbon condition, and that, although iron sulphide may have some influence, in the way suggested by Mr. Levy, on the eutectic, *it is the sulphur that crystallises with the carbide which is mainly responsible in preventing the separation of graphite by making the carbide more stable.*

If it is assumed that the stability of the carbide depends on the quantity of sulphur which crystallises with it, and not on the total amount present in the metal carrying the carbides, it is clear that a great field of research is now open, the borders of which I have barely touched to co-relate their stability and sulphur contents.

The microscope does not show in what constituent the silicon crystallises. It is known that in grey irons it is associated with the ferrite and pearlite; but grey iron is the final result of the decomposition of carbide of iron and possibly silico-carbides, which primarily form during solidification, and although the silicon in the decomposed product may be entirely associated with the iron, it is no proof that initially some of it may not have crystallised with the carbides.

In the white Cleveland iron, previously referred to, it is probable that the several constituents are present in the following proportions :—

	Per cent.
Silico-pearlite, the residue of the original austenite octahedral crystallites	42·50
Iron carbide in plates	33·66
Iron, phospho-carbide eutectic	23·10
Manganese sulphide	0·38
Iron sulphide	0·36
	100·00

When fractionally dissolving the powdered metal in acid, it was the iron and associated silicon of the pearlite which passed into solution, and the carbide and phosphide which remained insoluble, and as these contained only 0·12 per cent. silicon, or about 0·06 per cent. on 100 parts

FIG. 5.—Same as Fig. 4. Section cut parallel to the surface of a massive carbide plate.
The ground mass is carbide of iron.
The white dots are sulphide of iron.

of the original metal, it is evident that the pearlite must have contained 1·89 − 0·06 = 1·83 per cent. of the silicon, or on 100 parts of it $\frac{100 \times 1{\cdot}83}{42{\cdot}5} = 4{\cdot}3$ per cent., and that about 97 per cent. of the total silicon had crystallised with the austenite.

A little reflection will lead to the conclusion that if the carbon in the Cleveland white iron were to be gradually increased, the proportion of primary austenite crystallites would decrease; there would be less and less of them to carry the silicon, and this element would be concentrated in the diminishing solid austenite. It also follows that if the carbon were to be so increased that no primary austenite would form, the silicon would have to crystallise in some other constituent.

In the example, referred to above, of the chilled casting, the carbides contained only 0·028 per cent. silicon, or 0·016 per cent. on the original metal. In this case, therefore, about 98 per cent. had crystallised with the primary austenite.

The question as to what amount of silicon will crystallise with the austenite so as to saturate it is probably variable with other variables. To determine this by chemical analysis would involve an exceedingly tedious research.

It is probable that as it increases, and as the austenite approaches more and more nearly to the saturation point, a gradually increasing proportion of the silicon will crystallise with the carbides.

It is well known that molten low silicon grey irons, in the absence of any appreciable quantity of sulphur, gives a white fracture when slightly chilled. Irons with above 5 per cent. silicon, when similarly treated, are supposed not to behave in the same manner, and this is quite true when any ordinary method of chilling is adopted. For instance, when the liquid silicious glazed metal No. 1 was run into water, the chilled iron contained graphite; but when a large drop was suddenly pressed into a sheet as thin as paper between cold plates of iron, the chilled metal was quite white, and no graphite could be detected on dissolving it in nitric acid. The metal so chilled was difficult to dissolve in acid, and the silica produced, instead of forming a gelatinous bulky residue, remained in a close, dense condition—indeed, the thin chilled sheet, after all soluble matter had been removed, remained a rigid sheet of dense coherent silica, whereas the same metal allowed to cool slowly from the liquid state in a sand mould yielded to acid gelatinous silica.

FIG. 6.—Glazed Cleveland Iron after melting with a little Sulphide of Iron.
White crystals = primary carbo-silicide of iron.
Dark = the second cementite.
Complex structure = iron-carbon-phosphorus eutectic.

The different behaviour to acid treatment of the chilled as contrasted with that of the slowly cooled metal indicates that the condition of the silicon in rapidly chilled metal is different from its condition in the same metal slowly cooled.

In 1895 Mr. T. W. Hogg, of Newburn Steel Works, published an account of a very interesting observation, in which he showed the difference in the silicon solubility in different parts of the same pig iron, a portion of which was white and a portion grey. The iron referred to contained :—

	White part Per cent.		Grey part Per cent.	
Combined carbon ...	3·88	4·33	0·98	4·66
Graphitic carbon ...	0·45		3·68	
Silicon	0·65		0·85	
Manganese	1·63		1·60	

He determined the solubility in dilute acid of the silicon in each portion, and found that the silicon soluble in hydrochloric acid was, in the grey part = about 81 per cent. and in the white part = about 48 per cent.

He found also that the silica left on treating the two

varieties of metal in acid differed in character—that from the white portion was dense, whilst that from the grey metal was much more voluminous. The white metal contained the eutectic proportion of carbon, and therefore it could not contain any austenite crystallites; indeed, with the silicon 0·60 per cent. also present, it must be regarded as a hypereutectic alloy, and on that account we are forced to conclude that the silicon must have crystallised with the carbide.

It has long been known that on dissolving grey ferro-silicon containing even 6 per cent. silicon the silica gelatinises, whereas when the silicon approaches 10 per cent. much of the silica remains in a dense form. It is almost certain that during the solidification of the grey part of Mr. Hogg's pig iron a rich silicon cementite must have primarily formed, for the high carbon would not allow the formation of any primary silico-austenite; when this cementite decomposed the silicide part of it would become diluted with the iron of the decomposed carbide. It was, no doubt, this diluted solid solution in the cold grey metal which yielded the gelatinous silica.

That silicon does diffuse into iron, even at relatively low temperature, was proved by Lebeau. He found that free silicon and iron, when heated together *in vacuo* at 960° C., chemically combine, a fact I have fully confirmed, although it is impossible to get silicon to combine with iron on heating them together in a cementation furnace where oxidising gases have access to the silicon.

FIG. 7.—An Iron-Carbon-Silicon Alloy, free from Phosphorus, made more stable by Sulphur.
Broken-up structure in the centre=the eutectic of two cementites, silico-carbide and carbide.
Half-tone=the carbide cementite.
Dark area=decomposed eutectic.
Light portion at right lower corner=crystallite of silico-pearlite.

To determine whether silicide of iron would diffuse into and precipitate the graphite in white iron, a sample of crushed white iron free from impurities, containing 3·5 per cent. of carbon, was mixed with 10 per cent. by weight of a silicon alloy containing 20 per cent. of silicon ($=Fe_2Si$), also in powder. The mixture, after compression in a short piece of iron tube, was heated for two hours at 1000° C. in an atmosphere of hydrogen gas, and was then removed and cooled in air.

For comparison, a portion of the crushed white iron was treated in the same way.

The combined carbon in the metals before and after heating were as follows:—

	Before Per cent.	After Per cent.
In while metal alone	3·5	3·44
,, ,, and silicide ...	3·20	0·60

Not only does this trial prove that silicide does diffuse into carbide of iron and precipitate graphite, it has also an important bearing on the question as to why silicon in pig iron, even in small quantities, causes the carbide to be decomposed. In the experiments with the chilled part of a casting containing only 0·7 per cent. silicon and 3·75 per cent. carbon, it was shown that the carbide contained only 0·028 per cent. silicon, and that 98 per cent. of the total silicon was concentrated in the pearlite; yet this white iron, on heating to 1000° C., became quite grey. *Are we not justified in concluding that it was the diffusion of silicide of iron from the silico-austenite into the carbides which caused the separation of graphite?*

As I had proved, first that sulphur crystallises with and makes the carbide of iron more stable, and second that in the presence of a fusible mother liquor rich in phosphorus, after the austenite crystallisation is complete, the carbide crystallises out in plates and not as iron carbide eutectic, it appeared probable that if, as Gontermann premised, two kinds of cementite actually form during the solidification of iron-carbide-silicon alloys, it might be possible to obtain them in a separate state by melting the rich silicon alloys with a little sulphur.

In order to test this, a portion of the No. 1 grey glazed metal was melted, and when fluid a little sulphide of iron was mixed with it. The mixture was then cast in sand.

FIG. 8.—Pure Iron-Iron Carbide Eutectic, the cooling of which was arrested before the complete decomposition of the Carbides into Austenite and Graphite.
White=carbide of iron. Black lines=graphite.
Half-tone=pearlite.

Owing to the rapidity of the melting, some of the graphite escaped and floated on the surface of the metal.

When cold it was found that the lower part of the small casting gave a white fractured surface, whilst the upper part was close grey.

The analyses were as follows:—

	White part Per cent.	Grey part Per cent.
Combined carbon	2·06	0·60
Graphite	trace	1·46
Manganese	0·03	0·03
Silicon	5·41	5·40
Sulphur	0·88	0·91
Phosphorus...	1·50	1·50

The grey part, although slowly attacked by cold acid, did dissolve, yielding much voluminous silica. The white part was almost inert, and only dissolved in strong hydrochloric acid with difficulty, and when the iron was dissolved out the remaining silica was of the dense variety, from which it would appear that the effect of the sulphide is akin to that of sudden quenching.

It was the micro-structure of the white portion, however, which was of unique interest. On "heat-tinting" two kinds of hard crystals appeared, one more readily coloured by heating than the other. The more resistant crystals were idiomorphic, and were furnished with their terminal angles, but as they were embedded in the surrounding metal it was impossible to form any exact idea of the crystalline system to which they belonged.

The second order of crystals had evidently solidified at a later period, as their forms were interfered with by those of the idiomorphic type; they were much like ordinary plates of carbide of iron. The ground mass contained indications of octahedral on fir-tree crystallites and a well-developed phosphorus iron eutectic of the honeycomb type. This eutectic was the last to freeze, as it filled the spaces between the plates of the hard crystals. There was no pearlite excepting in the eutectic of phosphorus and iron. We can only tentatively conclude that, of the two cementites, the idiomorphic crystals contained the greater part of the silicon, because of their greater resistance to oxidation, and probably consisted of carbo-silicide of iron, with sufficient sulphur in them to make them stable; also that the second crystals were carbide of iron, possibly containing a lesser quantity or no silicide in solid solution.

A further series of experiments was made on a portion of the same metal. In this case the molten iron was mixed and agitated with free sulphur instead of sulphide of iron, and the metal was at once poured into a sand mould in a thin layer. When cold it was quite white in fracture, and had large, brilliant cleavage faces.

It had the following composition :—

	Per cent.
Combined carbon	2·60
Manganese	Trace
Silicon	6·65
Sulphur	0·93
Phosphorus	2·08

The sulphur had evidently effected concentration of the silicon, phosphorus, and carbon by removing some of the iron, as sulphide of iron was actually formed and floated on the surface of the iron. It was fractionally dissolved as described in previous cases, and the residue (72 per cent. of the weight of the original metal) was tested and found to contain :—

	Per cent.
Carbon	2·92
Manganese	Trace
Silicon	6·70
Sulphur	0·062
Phosphorus	1·410

This insoluble fraction evidently consisted of both classes of crystals, together with some phosphide of iron. Efforts were made to separate the crystals by chemical means, but without success.

On the long and continued action of strong hydrochloric acid a residue was obtained containing a little less carbon and more silicon than were present in the mixture, an indication that the less soluble portion is different from that more soluble.

The micro-structure was similar to that of the metals of the previous trial, but as the carbon and silicon were higher the carbo-silicide was in greater quantity. It crystallised in long flat plates, and not in relatively short idiomorphic crystals.

It is probable exception may be taken, with some justification, that the sulphur does not simply arrest the decomposition of the cementites, which I have premised primarily form, but may act in some other unknown way. An attempt was therefore made to find out whether they could be obtained by some other method without the aid of sulphur. As it is known that the ternary eutectic of iron, phosphorus, and carbon melts at about 945° C., it appeared probable that if silicon in small quantity were to be melted with an iron-carbon-phosphorus alloy very rich in phosphorus, the two kinds of cementites would fall out of solution at a lower temperature, and would probably not decompose into graphite and silico-austenite in cooling down after their formation. To ascertain whether or not this would be the case, a fusible iron-phosphorus-carbon alloy containing more than the eutectic proportion of carbon was made. It had the following composition :—

	Per cent.
Iron	91·89
Phosphorus	5·37
Carbon	2·62
Silicon, &c.	0·10
Sulphur	0·02
	100·00

Four hundred grams were melted with sufficient silicon alloy to yield in the mixture :—

	Per cent.
Carbon	2·4
Phosphorus	5·0
Silicon	2·90
Sulphur	0·02

When melted, a portion of it was cast in a sand mould; the remainder was allowed to cool in the crucible.

When cold, that cooled in the crucible was quite grey, whilst the portion cooled in sand was white at the lower part and grey on the top part of the casting, results which proved that the alloy was very unstable, and that decomposition of the lower part of the casting was arrested by the slight chilling effect of the cold sand.

On microscopic examination of the white portion, the ground mass was found to consist of the binary phosphorus iron eutectic, whilst two different cementites were embedded in it; one much more rapidly coloured on "heat-tinting" than the other. The colours of the constituents of the properly heated and polished metal were as follows :—

Cementite (*a*)	White
,, (*b*)	Red
Phosphide of iron	Purple
Iron pearlite crystallites	Grey

The part which broke with a grey fracture consisted of octahedral crystallites of silico-pearlite, the binary phosphorus iron eutectic, and undecomposed (red) cementite crystals, but there was a complete absence of the (white) cementite crystals. Graphite was also present in exceedingly fine plates, resembling what is known as temper graphite.

The evidence here is conclusive that even in the absence of sulphur :—

1st. Two cementites had formed.

2nd. That one cementite is much more unstable than the other variety, and decomposes in advance into silico-austenite and graphite.

Having proved that two different kinds of cementite do actually form and crystallise in the phosphorus eutectic, it remained to ascertain in what way these crystallise in the absence of the phosphorus eutectic.

For this purpose two hypo-eutectic alloys were prepared without any phosphorus, but with sufficient sulphide of iron to check the decomposition of the carbides.

They contained :—

	1 Per cent.	2 Per cent.
Carbon	2·40	2·10
Silicon	3·17	7·10
Sulphur	1·21	0·82
Phosphorus	0·02	0·02

These when cold, after casting in sand, broke with white fractures.

The carbides separated in the manner previously described contained :—

	1 Per cent.	2 Per cent.
Carbon	6·16	3·00
Sulphur	0·09	0·08
Silicon	0·97	7·93
Percentage of carbides insoluble in acid	27·5	50·00

The repeated acid treatment in this, as in all previous cases, no doubt dissolved a portion of the carbides, and what was actually weighed represented only a part of those actually present in the alloys.

In No. 2 alloy, after polishing and "heat-tinting," the

microscope proved the presence of a few fir-tree crystallites embedded in a ground mass of cementite and a eutectic containing the two kinds of cementite, the No. 1 specimen containing a much smaller proportion of the cementite rich in silicon than No. 2.

As the metals had been somewhat rapidly cooled, the alloy No. 2 was remelted, and was then allowed to cool in the crucible, so as to obtain a more coarsely crystallised eutectic. When cold, on polishing and "heat-tinting," the eutectic was clearly seen. There were the remains of large primary silico-austenite crystallites, plates of the red-coloured cementite, and a well-developed eutectic consisting of the (red) coloured and (white) cementites.

The cooling having been slow, this compound constituent had suffered partial decomposition in isolated patches into graphite and silico-ferrite, whilst the cementite coloured red remained intact.

There can be little doubt that the residue left insoluble in acid consisted of the two cementites, but in what proportion it is impossible to tell, as a method for isolating them has yet to be found.

Had the alloy contained a greater proportion of carbon, the amount of cementite rich in silicon would have been in much greater proportion.

The trials, incomplete and necessarily imperfect as they are, go far to prove, just as Gontermann premised, that during the solidification of high silicon pig irons two cementites fall out of solution together as a eutectic mixture.

They also have proved that the carbo-silicides are exceedingly unstable, breaking up into silico-austenite almost as soon as formed. *It is the instability of these silico-carbides which is mainly responsible for the graphitic character of grey irons rich in silicon and low in sulphur.*

Summary and Conclusions.

(1) The experimental results advanced show proof that carbide of iron in presence of iron sulphide crystallises with a minute quantity of sulphur not exceeding about one-thousandth part of the weight of the carbide, but the nature of the iron-carbon-sulphur compound has not yet been determined.

(2) It seems almost, if not absolutely, certain that it is the sulphur crystallised with the carbide which makes the latter stable.

(3) The evidence appears to support the view, long held by some, and more recently accepted by others, that during the freezing of iron-carbon-hypo-eutectic alloys after the crystallisation of the primary austenite, and in the eutectic and hypereutectic alloys, it is the carbide, and not graphite, which primarily forms, and that the carbide afterwards decomposes into graphite and austenite.

(4) It has been proved by chemical methods that when the hypo-eutectic alloys, low in silicon, freeze, nearly all the silicon crystallises out with the primary austenite; and it follows that on gradually increasing the carbon so as to reduce the quantity of primary austenite, the silicon remaining constant, the austenite which does form must be as gradually enriched in silicon up to saturation point, and, when that point is reached, the excess silicon crystallises out with a portion of the carbide of iron to form carbo-silicide of iron. Other elements remaining constant, the same result must follow on gradually increasing the silicon.

(5) In the alloys of eutectic proportion and in the hypereutectic alloys, as no primary austenite can form, the silicon crystallises primarily with the carbide.

(6) In Cleveland pig iron containing about 1·5 per cent. phosphorus, a ternary eutectic of iron-carbon-phosphorus takes the place of the iron-iron-carbide eutectic. In white irons containing 3 per cent. carbon and under 2 per cent. silicon, after the primary austenite has fallen out of solution, carrying practically all the silicon, it is not iron-iron-carbide which forms, but independent plates of cementite, or carbide of iron, and after these have crystallised and the residual mother liquor has arrived at the composition of the ternary iron-carbon-phosphorus eutectic, the latter solidifies at 945° C.

(7) In Cleveland irons which become grey on cooling, and in which there is no primary austenite, the same iron-carbon-phosphorus eutectic is the only eutectic to form during cooling, and, instead of a ternary iron-carbon-silicon eutectic, two independent cementites crystallise—one a silico-carbide and the other carbide of iron, possibly containing a little silicide in solid solution. The micro-examination of the cold alloys, to which a little sulphur had previously been added when the metals were melted, led to the conclusion that it is the carbo-silico-cementite which primarily crystallises.

(8) There is evidence that the primary carbo-silicides are exceedingly unstable, and are the first to decompose into graphite and silico-austenite.

(9) In the absence of any sensible quantity of phosphorus, two cementites form—one the silico-carbide cementite, the other the carbide cementite—and these crystallise together as a eutectic mixture.

(10) The exact composition of the two cementites has not yet been determined, as no chemical method has been found for their isolation.

(11) It is evident that it is the exceedingly unstable character of the silico-carbides which is responsible for the greyness of commercial metals rich in silicon and low in sulphur.

(12) Silicide of iron when heated at 1000° C. with pure white iron free from silicon effects the decomposition of the carbide of the white iron. Based on this observation, the hypothesis seems justifiable, in cases where all the silicon present in hypo-eutectic alloys crystallises out with the primary austenite, that after the carbide has solidified diffusion of the silicide follows, and this leads to the decomposition of the carbide of iron into graphite of iron.

(13) Many of the results arrived at by chemical analysis support the hypothetical conclusions of Gontermann, who depended mainly on data obtained by thermal methods of treatment.

In conclusion, it will be clear from what I have stated that there are many gaps yet to be filled. I hope that the knowledge of this fact will lead others to follow up the research, which, in its present stage, is far from complete.

SUB-SECTION OF B.

AGRICULTURAL SUB-SECTION.

OPENING ADDRESS BY A. D. HALL, M.A., F.R.S., CHAIRMAN OF THE SUB-SECTION.

I BELIEVE it is customary for anyone who has the honour of presiding over a section of the British Association to provide in his presidential address either a review of the current progress of his subject or an account of some large piece of investigation by which he himself has illuminated it. I wish I had anything of the latter kind which I could consider worthy to occupy your attention for the time at my disposal; and as to a review of the subject, I am not without hopes that the sectional meetings themselves will provide all that is necessary in the way of a general review of what is going forward in our department of science. I have, therefore, chosen instead to deal from an historic point of view with the opinions which have prevailed about one central fact, and I propose to set before you this morning an account of the ebb and flow of ideas as to the causes of the fertility of the soil, a question which has naturally occupied the attention of everyone who has exercised his reason upon matters connected with agriculture. The fertility of the soil is perhaps a vague title, but by it I intend to signify the greater or less power which a piece of land possesses of producing crops under cultivation, or, again, the causes which make one piece of land yield large crops when another piece alongside only yields small ones, differences which are so real that a farmer will pay three or even four pounds an acre rent for some land, whereas he will regard other as dear at ten shillings an acre.

If we go back to the seventeenth century, which we may take as the beginning of organised science, we shall find that men were concerned with two aspects of the question—how the plant itself gains its increase in size, and, secondly, what the soil does towards supplying the material constituting the plant. The first experiment we have recorded is that of Van Helmont, who placed 200 lb. of dried earth in a tub, and planted therein a willow tree weighing 5 lb. After five years the willow tree weighed

169 lb. 3 oz., whereas the soil, when redried, had lost but 2 oz., though the surface had been carefully protected meantime with a cover of tin. Van Helmont concluded that he had demonstrated a transformation of water into the material of the tree. Boyle repeated these experiments, growing pumpkins and cucumbers in weighed earth, and obtaining similar results, except when his gardener lost the figures, an experience that has been repeated. Boyle also distilled his pumpkins, &c., and obtained therefrom various tars and oils, charcoal and ash, from which he concluded that a real transmutation had been effected, "that salt, spirit, earth, and even oil (though that be thought of all bodies the most opposite to water) may be produced out of water."

There were not, however, wanting among Boyle's contemporaries men who pointed out that spring water used for the growing plants in these experiments contained abundance of dissolved material, but in the then state of chemistry the discussion as to the origin of the carbonaceous material in the plant could only be verbal. Boyle himself does not appear to have given any consideration to the part played by the soil in the nutrition of plants, but among his contemporaries experiment was not lacking. Some instinct seems to have led them to regard nitre as one of the sources of fertility, and we find that Sir Kenelm Digby, at Gresham College in 1660, at a meeting of the Society for Promoting Philosophical Knowledge by Experiment, in a lecture on the vegetation of plants, describes an experiment in which he watered young barley plants with a weak solution of nitre, and found how their growth was promoted thereby; and John Mayow, that brilliant Oxford man whose early death cost so much to the young science of chemistry, went even further, for, after discussing the growth of nitre in soils, he pointed out that it must be this salt which feeds the plant, because none is to be extracted from soils in which plants are growing. So general has this association of nitre with the fertility of soils become, that in 1675 John Evelyn writes: "I firmly believe that where saltpetre can be obtained in plenty we should not need to find other composts to ameliorate our ground"; and Henshaw, of University College, one of the first members of the Royal Society, also writes about saltpetre: "I am convinced, indeed, that the salt which is found in vegetables and animals is but the nitre which is so universally diffused through all the elements (and must therefore make the chief ingredient in their nutriment, and by consequence all their generation), a little altered from its first complexion."

But these promising beginnings of the theory of plant nutrition came to no fruition; the Oxford movement in the seventeenth century was but the false dawn of science. At its close the human mind, which had looked out of doors for some relief from the fierce religious controversy with which it had been so long engrossed, turned indoors again and went to sleep for another century. Mayow's work was forgotten, and it was not until Priestly and Lavoisier, De Saussure, and others, about the beginning of the nineteenth century, arrived at a sound idea of what the air is and does that it became possible to build afresh a sound theory of the nutrition of the plant. At this time the attention of those who thought about the soil was chiefly fixed upon the humus. It was obvious that any rich soils, such as old gardens and the valuable alluvial lands, contained large quantities of organic matter, and it became somewhat natural to associate the excellence of these fat, unctuous soils with the organic matter they contained. It was recognised that the main part of a plant consisted of carbon, so that the deduction seemed obvious that the soils rich in carbon yielded those fatty, oily substances which we now call humus to the plant, and that their richness depended upon how much of such material they had at their disposal. But by about 1840 it had been definitely settled what the plant is composed of and whence it derives its nutriment—the carbon compounds which constitute nine-tenths of the dry weight from the air, the nitrogen, and the ash from the soil. Little as he had contributed to the discovery, Liebig's brilliant expositions and the weight of his authority had driven this broad theory of plant nutrition home to men's minds; a science of agricultural chemistry had been founded, and such questions as the function of the soil with regard to the plant could be studied with some prospect of success. By this time, also, methods of analysis had been so far improved that some quantitative idea could be obtained as to what is present in soil and plant, and, naturally enough, the first theory to be framed was that the soil's fertility was determined by its content of those materials which are taken from it by the crop. As the supply of air from which the plant derives its carbonaceous substance is unlimited, the extent of growth would seem to depend upon the supply available of the other constituents which have to be provided by the soil. It was Daubeny, Professor of Botany and Rural Economy at Oxford, and the real founder of a science of agriculture in this country, who first pointed out the enormous difference between the amount of plant food in the soil and that taken out by the crop. In a paper published in the Philosophical Transactions in 1845, being the Bakerian Lecture for that year, Daubeny described a long series of experiments that he had carried out in the Botanic Garden, wherein he cultivated various plants, some grown continuously on the same plot and others in a rotation. Afterwards he compared the amount of plant food removed by the crops with that remaining in the soil. Daubeny obtained the results with which we are now familiar, that any normal soil contains the material for from fifty to a hundred field crops. If, then, the growth of the plant depends upon the amount of this material it can get from the soil, why is that growth so limited, and why should it be increased by the supply of manure, which only adds a trifle to the vast stores of plant food already in the soil? For example, a turnip crop will only take away about 30 lb. per acre of phosphoric acid from a soil which may contain about 3000 lb. an acre; yet, unless to the soil about 50 lb. of phosphoric acid in the shape of manure is added, hardly any turnips at all will be grown. Daubeny then arrived at the idea of a distinction between the active and dormant plant food in the soil. The chief stock of these materials, he concluded, was combined in the soil in some form that kept it from the plant, and only a small proportion from time to time became soluble and available for food. He took a further step, and attempted to determine the proportion of the plant food which can be regarded as active. He argued that since plants only take in materials in a dissolved form, and as the great natural solvent is water percolating through the soil more or less charged with carbon dioxide, therefore in water charged with carbon dioxide he would find a solvent which would extract out of a soil just that material which can be regarded as active and available for the plant. In this way he attacked his Botanic Garden soils, and compared the materials so dissolved with the amount taken away by his crops. The results, however, were inconclusive, and did not hold out much hope that the fertility of the soil can be measured by the amount of available plant food so determined. Daubeny's paper was forgotten; but exactly the same line of argument was revived again about twenty years ago, and all over the world investigators began to try to measure the fertility of the soil by determining as "available" plant food the phosphoric acid and potash that could be extracted by some weak acid. A large number of different acids were tried, and although a dilute solution of citric acid is at present the most generally accepted solvent, I am still of opinion that we shall come back to the water charged with carbon dioxide as the only solvent of its kind for which any justification can be found. Whatever solvent, however, is employed to extract from the soil its available plant food, the results fail to determine the fertility of the soil, because we are measuring but one of the factors in plant production, and that often a comparatively minor one. In fact, some investigators—Whitney and his colleagues in the American Department of Agriculture—have gone so far as to suppose that the actual amount of plant food in the soil is a matter of indifference. They argue that as a plant feeds upon the soil water, and as that soil water must be equally saturated with, say, phosphoric acid, whether the soil contains 1000 or 3000 lb. per acre of the comparatively insoluble calcium and iron salts of phosphoric acid which occur in the soil, the plant must be under equal conditions as regards phosphoric acid, whatever the soil in which it may be grown. This argu-

ment is, however, a little more suited to controversy than to real life; it is too fiercely logical for the things themselves, and depends upon various assumptions holding rigorously, whereas we have more reason to believe that they are only imperfect approximations to the truth. Still, this view does merit our careful attention, because it insists that the chief factor in plant production must be the supply of water to the plant, and that soils differ from one another far more in their ability to maintain a good supply of water than in the amount of plant food they contain. Even in a climate like our own, which the text-books describe as "humid" and we are apt to call "wet," the magnitude of our crops is more often limited by want of water than by any other single factor. The same American investigators have more recently engrafted on to their theory another supposition, that the fertility of soil is often determined by excretions from the plants themselves, which thereby poison the land for a renewed growth of the same crop, though the toxin may be harmless to a different plant which follows it in the rotation. This theory had also been examined by Daubeny, and the arguments he advanced against it in 1845 are valid to this day. Schreiner has, indeed, isolated a number of organic substances from soils—di-hydroxystearic acid and picoline-carboxylic acid were the first examples—which he claims to be the products of plant growth and toxic to the further growth of the same plants. The evidence of toxicity as determined by water-cultures requires, however, the greatest care in interpretation, and it is very doubtful how far it can be applied to soils with their great power of precipitating or otherwise putting out of action soluble substances with which they may be supplied. Moreover, there are as yet no data to show whether these so-called toxic substances are not normal products of bacterial action upon organic residues in the soil, and as such just as abundant in fertile soils rich in organic matter as in the supposed sterile soils from which they were extracted.

As, then, we have failed to base a theory of fertility on the plant food that we can trace in the soil by analysis, let us come back to Mayow and Digby, and consider again the nitre in the soil—how it is formed and how renewed. Their views of the value of nitrates to the plant were justified when the systematic study of plant-nutrition began, and demonstrated that plants can only obtain their supply of the indispensable element nitrogen when it is presented in the form of a nitrate; but it was not until within the last thirty years that we obained an idea as to how the nitre came to be found. The oxidation of ammonia and other organic compounds of nitrogen to the state of nitrate was one of the first actions in the soil which was proved to be brought about by bacteria, and by the work of Schloesing and Müntz, Warington and Winogradsky, we learnt that in all cultivated soils two groups of bacteria exist which successively oxidise ammonia to nitrites and nitrates, in which latter state the nitrogen is available for the plant. These same investigators showed that the rate at which nitrification takes place is largely dependent upon operations under the control of the farmer; the more thorough the cultivation, the better the drainage and aëration, and the higher the temperature of the soil, the more rapidly will the nitrates be produced. As it was then considered that the plant could only assimilate nitrogen in the form of nitrates, and as nitrogen is the prime element necessary to nutrition, it was then an easy step to regard the fertility of the soil as determined by the rate at which it would give rise to nitrates. Thus the bacteria of nitrification became regarded as a factor, and a very large factor, in fertility. This new view of the importance of the living organisms contained in the soil further explained the value of the surface soil, and demolished the fallacy which leads people instinctively to regard the good soil as lying deep and requiring to be brought to the surface by the labour of the cultivator. This confusion between mining and agriculture probably originated in the quasi-moral idea that the more work you do the better the result will be; but its application to practice with the aid of a steam plough in the days before bacteria were thought of ruined many of the clay soils of the Midlands for the next half-century. Not only is the subsoil deficient in humus, which is the accumulated débris of previous applications of manure and vegetation, but the humus is the home of the bacteria which have so much to do with fertility.

The discovery of nitrification was only the first step in the elucidation of many actions in the soil depending upon bacteria—for example, the fixation of nitrogen itself. A supply of combined nitrogen in some form or other is absolutely indispensable to plants and, in their turn, to animals; yet, though we live in contact with a vast reservoir of free nitrogen gas in the shape of the atmosphere, until comparatively recently we knew of no natural process except the lightning flash which would bring such nitrogen into combination. Plants take combined nitrogen from the soil, and either give it back again or pass it on to animals. The process, however, is only a cyclic one, and neither plants nor animals are able to bring in fresh material into the account. As the world must have started with all its nitrogen in the form of gas, it was difficult to see how the initial stock of combined nitrogen could have arisen; for that reason many of the earlier investigators laboured to demonstrate that plants themselves were capable of fixing and bringing into combination the free gas in the atmosphere. In this demonstration they failed, though they brought to light a number of facts which were impossible to explain, and only became cleared up when, in 1886, Hellreigel and Wilfarth showed that certain bacteria, which exist upon the roots of leguminous plants, like clover and beans, are capable of drawing nitrogen from the atmosphere. Thus they not only feed the plant on which they live, but they actually enrich the soil for future crops by the nitrogen they leave behind in the roots and stubble of the leguminous crop. Long before this discovery experience had taught farmers the very special value of these leguminous crops; the Roman farmer was well aware of their enriching action, which is enshrined in the well-known words in the Georgics beginning, "Aut ibi flava seres," where Virgil says that the wheat grows best where before the bean, the slender vetch, or the bitter lupin had been most luxuriant. Since the discovery of the nitrogen-fixing organisms associated with leguminous plants, other species have been found resident in the soil which are capable of gathering combined nitrogen without the assistance of any host plant, provided only they are supplied with carbonaceous material as a source of energy whereby to effect the combination of the nitrogen. To one of these organisms we may with some confidence attribute the accumulation of the vast stores of combined nitrogen contained in the black virgin soils of places like Manitoba and the Russian steppes. At Rothamsted we have found that the plot on the permanent wheat field which never receives any manure has been losing nitrogen at a rate which almost exactly represents the differences between the annual removal of the crop and the receipts of combined nitrogen in the rain. We can further postulate only a very small fixation of nitrogen to balance the other comparatively small losses in the drainage water or in the weeds that are removed; but on a neighbouring plot, which has been left waste for the last quarter of a century, so that the annual vegetation of grass and other herbage falls back to the soil, there has been an accumulation of nitrogen representing the annual fixation of nearly a hundred pounds per acre. The fixation has been possible by the *azotobacter* on this plot, because there alone does the soil receive a supply of carbohydrate, by the combustion in which the *azotobacter* obtained the energy necessary to bring the nitrogen into combination. On the unmanured plot the crop is so largely removed that the little root and stubble remaining does not provide material for much fixation.

Though numerous attempts have been made to correlate the fertility of the soil with the numbers of this or that bacterium existing therein, no general success has been attained, because probably we measure a factor which is only on occasion the determining factor in the production of the crop. Meantime, our sense of the complexity of the actions going on in the soil has been sharpened by the discovery of another factor, affecting in the first place the bacterial flora in the soil, and, as a consequence, its fertility. Ever since the existence of bacteria has been recognised, attempts have been made to obtain soils in a

sterile condition, and observations have been from time to time recorded to the effect that soil which has been heated to the temperature of boiling water, in order to destroy any bacteria it may contain, had thereby gained greatly in fertility, as though some large addition of fertiliser had been made to it. Though these observations have been repeated in various times and places, they were generally ignored, because of the difficulty of forming any explanation: a fact is not a fact until it fits into a theory. Not only is sterilisation by heating thus effective, but other antiseptics, like chloroform and carbon bisulphide vapour, give rise to a similar result. For example, you will remember how the vineyards of Europe were devastated some thirty years ago by the attacks of phylloxera, and though in a general way the disease has been conquered by the introduction of a hardy American vine stock which resists the attack of the insect, in many of the finest vineyards the owners have feared to risk any possible change in the quality of the grape through the introduction of the new stock, and have resorted instead to a system of killing the parasite by injecting carbon bisulphide into the soil. An Alsatian vine-grower who had treated his vineyards by this method observed that an increase of crop followed the treatment even in cases where no attack of phylloxera was in question. Other observations of a similar character were also reported, and within the last five years the subject has received some considerable attention, until the facts became established beyond question. Approximately the crop becomes doubled if the soil has first been heated to a temperature of 70° to 100° for two hours, while treatment for forty-eight hours with the vapour of toluene, chloroform, &c., followed by a complete volatilisation of the antiseptic, brings about an increase of 30 per cent. or so. Moreover, when the material so grown is analysed, the plants are found to have taken very much larger quantities of nitrogen and other plant foods from the treated soil; hence the increase of growth must be due to larger nutriment and not to mere stimulus. The explanation, however, remained in doubt until it has been recently cleared up by Drs. Russell and Hutchinson, working in the Rothamsted laboratory. In the first place, they found that the soil which had been put through the treatment was chemically characterised by an exceptional accumulation of ammonia, to an extent that would account for the increased fertility. At the same time, it was found that the treatment did not effect complete sterilisation of the soil, though it caused at the outset a great reduction in the numbers of bacteria present. This reduction was only temporary, for as soon as the soil was watered and left to itself the bacteria increased to a degree that is never attained under normal conditions. For example, one of the Rothamsted soils employed contains normally about seven million bacteria per gram—a number which remains comparatively constant under ordinary conditions. Heating reduced the numbers to 400 per gram, but four days later they had risen to six million, after which they increased to more than forty million per gram. When the soil was treated with toluene a similar variation in the number of bacteria was observed. The accumulation of ammonia in the treated soils was accounted for by this increase in the number of bacteria, because the two processes went on at about the same rate. Some rearrangements were effected also in the nature of the bacterial flora; for example, the group causing nitrification was eliminated, though no substantial change was effected in the distribution of the other types. The bacteria which remained were chiefly of the class which split up organic nitrogen compounds into ammonia, and as the nitrate-making organisms which normally transform ammonia in the soil as fast as it is produced had been killed off by the treatment, it was possible for the ammonia to accumulate. The question now remaining was, What had given this tremendous stimulus to the multiplication of the ammonia-making bacteria? and by various steps, which need not here be enumerated, the two investigators reached the conclusion that the cause was not to be sought in any stimulus supplied by the heating process, but that the normal soil contained some negative factor which limited the multiplication of the bacteria therein. Examination along these lines then showed that all soils contain unsuspected groups of large organisms of the protozoa class, which feed upon living bacteria. These are killed off by heating or treatment by antiseptics, and on their removal the bacteria, which partially escape the treatment, and are now relieved from attack, increase to the enormous degree that we have specified. According to this theory, the fertility of a soil containing a given store of nitrogen compounds is limited by the rate at which these nitrogen compounds can be converted into ammonia, which, in its turn, depends upon the number of bacteria present effecting the change, and these numbers are kept down by the larger organisms preying upon the bacteria. The larger organisms can be removed by suitable treatment, whereupon a new level of ammonia production, and therefore of fertility, is rapidly attained. Curiously enough, one of the most striking of the larger organisms is an amœba akin to the white corpuscles of the blood—the phagocytes, which, according to Metchnikoff's theory, preserve us from fever and inflammation by devouring such intrusive bacteria as find entrance in the blood. The two cases are, however, reversed: in the blood the bacteria are deadly, and the amœba therefore beneficial, whereas in the soil the bacteria are indispensable, and the amœba become noxious beasts of prey.

Since the publication of these views of the functions of protozoa in the soil, confirmatory evidence has been derived from various sources. For example, men who grow cucumbers, tomatoes, and other plants under glass are accustomed to make up extremely rich soils for the intensive culture they practise, but, despite the enormous amount of manure they employ, they find it impossible to use the same soil for more than two years. Then they are compelled to introduce soil newly taken from a field and enriched with fresh manure. Several of these growers here have observed that a good baking of this used soil restores its value again; in fact, it becomes too rich, and begins to supply the plant with an excessive amount of nitrogen. It has also been pointed out that it was the custom of certain of the Bombay tribes to burn vegetable rubbish mixed, as far as possible, with the surface soil before sowing their crop, and the value of this practice in European agriculture, though forgotten, is still on record in the books on Roman agriculture. We can go back to the Georgics again, and there find an account of a method of heating the soil before sowing, which has only received its explanation within the last year, but which in some form or other has got to find its way back again into the routine of agriculture. Indeed, I am informed that one of the early mysteries, many of which we know to be bound up with the practices of agriculture, culminated in a process of firing the soil preparatory to sowing the crop.

My time has run out, and I fear that the longer I go on the less you will feel that I am presenting you with any solution of the problem with which we set out—"What is the cause of the fertility of the soil?" Evidently there is no simple solution; there is no single factor to which we can point as *the* cause; instead, we have indicated a number of factors any one of which may at a given time become a limiting factor and determine the growth of the plant. All that science can do as yet is to ascertain the existence of these factors one by one and bring them successively under control; but, though we have been able to increase production in various directions, we are still far from being able to disentangle all the interacting forces the resultant of which is represented by the crop.

One other point, I trust, my sketch may have suggested to you: when science, a child of barely a century's growth, comes to deal with a fundamental art like agriculture, which goes back to the dawn of the race, it should begin humbly by accepting and trying to interpret the long chain of tradition. It is unsafe for science to be dogmatic; the principles upon which it relies for its conclusions are often no more than first approximations to the truth, and the want of parallelism, which can be neglected in the laboratory, gives rise to wide divergencies when produced into the regions of practice. The method of science is, after all, only an extension of experience. What I have endeavoured to show in my discourse is the continuous thread which links the traditional practices of agriculture with the most modern developments of science.

NOTES.

MADAME CURIE and M. Debierne have presented a joint memoir to the Paris Academy of Sciences announcing that they have succeeded in isolating pure radium. The metallic radium obtained is reported to be of a brilliant white colour, which blackens when exposed to the air. It burns paper, rapidly decomposes water, and adheres to iron.

THE chief chemist of the Barrow works of Messrs. Vickers, Sons and Maxim announces the discovery of an alloy which is believed to be superior to anything of its kind hitherto manufactured, and is to be known as duralumin. While being slightly heavier than pure aluminium, it is reported to be as strong as steel, and it can be rolled, drawn, stamped, extended, or forged at suitable temperatures. It is less corrodable than other high aluminium alloys under all the usual corrosive tests, and possesses many valuable properties. It is only one-third the weight of brass.

ACCORDING to *Science*, Dr. Charles Fahlberg, who was associated with Prof. Ira Remsen in the discovery of saccharine, died at Bad Nassau on August 15.

THE *Times* announces the death, at Cintra, of Prof. Pedroso, president of the Geographical Society of Lisbon.

THE centenary of the death of the famous Italian naturalist Filippo Cavolini will be commemorated by a series of meetings to be held in Naples on September 12–14. The arrangements are in the hands of a committee, the presidents of which are Profs. Monticelli and Cavara, professors of zoology and botany in the Royal University of Naples, and the inaugural meeting will be held in the Great Hall of that University on September 12 at 10 a.m.

THE following are the arrangements for the opening of the winter session of the London medical schools:—St. George's Hospital, King's College Hospital, and London Hospital will open on October 1. At the first-named Dr. S. Squire Sprigge will deliver an oration "On Prizes." St. Bartholomew's Hospital, Charing Cross Hospital (at which Dr. F. W. Mott, F.R.S., will deliver the eighth Huxley lecture, on "The Hereditary Aspect of Nervous and Mental Diseases"), Guy's Hospital, London (Royal Free Hospital) School of Medicine for Women (at which an address on "Women's Sphere in Medicine" will be given by Dr. E. W. Roughton), Middlesex Hospital, St. Mary's Hospital, University College Hospital, and Westminster Hospital will reopen on October 3. The opening day for St. Thomas's Hospital is October 4, and that of the London School of Tropical Medicine is October 14, when Dr. H. A. Miers, F.R.S., will give an address. At the opening of the medical school of the Victoria University of Manchester, on October 3, Prof. W. Thorburn will speak on "The Evolution of Surgery."

THE second International Congress for the Preservation of Game was opened at Vienna on Monday last. At one of the sections a message from King George to Mr. F. C. Selous, urging the desirability of making international provision for the preservation of migratory game birds, especially woodcock and quail, was read. A resolution in the sense of the King's message was adopted by the section. The next congress, which will meet in three years' time, is to be devoted chiefly to the preservation of game outside Europe.

SPEAKING as president of the twenty-fifth Congress of the Royal Sanitary Institute (now in session at Brighton), Sir John Cockburn said the history of the growth of sanitary science is epitomised in that of the Royal Sanitary Institute, which during the last quarter of a century has exercised a continually increasing influence for good on the health of the nation. Cleanliness, fresh air, pure food, and prevention of infection are the key-notes of modern medicine. In every city ample provision for baths should be made available for the masses. But cleanliness should not be confined to external appearance. Clean air is required. It is true that recent years have witnessed some improvements in this respect. The ventilation of our theatres also is not so bad as it was. It is perhaps in railway travelling that those who love to keep their bodies pure suffer most. There are smoking carriages for those who affect the weed; why not fresh-air carriages also, in which any occupant could demand that one at least of the windows shall be kept open? The objectors generally express the fear of catching cold. It is high time that this fallacy were exploded. What is called a cold in the head is an infectious disease, and is caught nowhere so readily as in close compartments. Fresh air, far from being the cause, is the best preventive.

THE treaty by which the Sovereign rights of the Korean Emperor are transferred to the Emperor of Japan came into effect on Monday, August 29, when it was promulgated in Seoul and Tokyo. The Korean peninsula, about equal in size to Great Britain, has thus become an integral part of Japanese territory. The Japanese Embassy has issued the following announcement, received from the Foreign Office at Tokyo, referring to the annexation:—(1) Korea shall hereafter be named "Chosen"; (2) the Government-General shall be established in Chosen; (3) the Residency-General and its accessory offices will be in existence for the present, and the Resident-General will exercise the functions of the Governor-General; (4) the issue of special passports for the people of Chosen is abolished, and hereafter the Chosens will be treated on an equal footing as the Japanese in the matter.

IT being possible to allot space in the Chemical Court of the reconstituted British Section of the Brussels Exhibition only to little more than half of the original exhibitors, a letter has been addressed by Sir Boverton Redwood, chairman of the Chemical Industries Committee, to the remaining firms asking them to funish a descriptive account of their exhibits, with photographs if possible, for display on a wall space which has been appropriated for the purpose. It is suggested that a convenient size for the framed account would be 4 feet by 3 feet, but in exceptional circumstances it is hoped that room may be found for a larger frame. Frames will be supplied free of cost by the Exhibition Branch of the Board of Trade, to whom photographs should be sent at the earliest possible date, as the new British Section of the exhibition is to be formally opened on September 15.

THE twenty-first annual general meeting of the Institution of Mining Engineers is to be held at Nottingham on Wednesday, September 14, when the following papers will be presented:—The mining school at Bochum, Prof. H. Louis; progress in the use of exhaust-steam power, Mr. J. Burns; the Elliott-Jones vertical coke-oven, Mr. T. C. Futers. In addition, the undermentioned communications, which have already appeared in the Transactions of the institution, will be open for discussion:—A storage-battery extension to a three-phase colliery power-plant, Mr. W. Maurice; measurements of the increase of temperature in

bore-holes, with the depth, the technics, and practical importance of the same for geological prognosis, with reference to new measurements in Mexico, Borneo, and in Central Europe, Drs. J. Kœnigsberger and M. Mühlberg; experiments illustrative of the inflammability of mixtures of coal-dust and air, Prof. P. Phillips Bedson; some memoranda concerning coal-dust and the essential principles of the coal-dust theory, Mr. H. W. G. Halbaum; the use of concrete for mine support, Prof. W. R. Crane; fire-damp caps and the detection of fire-damp in mines by means of safety-lamps, Messrs. E. B. Whalley and W. M. Tweedie; equipment for the study of flame-caps and for miscellaneous experiments on safety-lamps, Prof. G. R. Thompson.

THE second International Conference for the Study of Cancer is to be held in Paris on October 1–5 under the presidency of Prof. Czerny. French, English, and German are to be the official languages of the conference. Intending members should give notice to the treasurer, Dr. A. de Rothschild, 6 rue Saint-Philippe de Roule, Paris VIII^e.

THE ninth International Conference on Tuberculosis will take place at Brussels on October 5–8. Among the subjects likely to be brought under consideration are:—Hereditary tuberculosis contagion; the pre-disposition to the disease; the protection of children against tuberculosis; tuberculosis and the school; the part of women in the campaign against tuberculosis. Reports on the progress of the war against tuberculosis in different countries, milk supply, solar radiation, international statistics, and international marks indicating the condition of the lungs will be presented, and a paper will be read by Dr. Nathan Raw on the general measures recommended by the International Conference to the public authorities for the prevention of the spread of tuberculosis in different countries. The address of the Secretariat of the conference is Avenue Van Volxem, 253, Forest-Brussels.

IN connection with the Turin International Exhibition to be held in 1911, there is to be a competition in the transmission and reception of messages with Morse, Hughes, and Baudot apparatus. According to the *Electrician*, the tests will begin on August 22, and will be open to members of either sex of the staffs of telegraph administrations and army or navy telegraphists. The tests will include twenty minutes' transmission and thirty minutes' reception of messages by the Morse apparatus, the receiving being done with either the sounder or the writing instrument; and one hour of transmission by Hughes apparatus, mechanical or electrical, and with either E or W key; and one hour of transmission by Baudot quadruple apparatus. The text will be in languages suitable to the operators, will be printed on sheets containing fifty words each, and will consist of words, groups of letters, and figures. The text will be different for each system, but the same for competitors in the same system. A special test for reception by sounder and the writing of the text by a writing machine (the writing machine being provided by the competitor) will also be held, if not less than ten competitors belonging to three different administrations apply by June 15, 1911. The transmission will be effected in accordance with the International Telegraph Regulations. There will be a championship cup, which will remain the property of the successful competitor, and be competed for by competitors who gain a prize in each of the three systems (Morse, Hughes, and Baudot). There will also be an international representation prize cup to be competed for by groups of three competitors who all represent one State, and have between them won prizes in all the three sections. There will also be individual prizes—ten for the Morse, eight for the Hughes, and eight for the Baudot tests. Applications must be sent by June 15 next to the Secretariat General, Bureau du Concours International de Telegraphie, Rome.

IN *Man* for August Mr. C. M. Woodford describes a remarkable stone-headed axe from Rennell Island which he has been fortunate enough to acquire. He shows that this weapon is in type quite different from the examples with which it has been compared found in Malaita, in which a nodule of iron pyrites is attached to a handle ornamented with nautilus or pearl shell. In the Rennell Island example, the head, formed apparently of a basaltic stone, is star-shaped with eight projections, and is attached to a plain handle made of a hard, dark wood, probably *Afzelia bijuga*. The union is effected by an ingenious system of rattan lashings, which pass through holes in the handle.

MR. T. SHEPPARD, the energetic curator of the Hull Museum, in his annual report for 1909 records important accessions to the valuable collections in his charge. On the antiquarian side, the most important addition is the famous Brigg boat, constructed from a single trunk of oak, 50 feet long and 6 feet broad. From the caulking Mr. Slater has been able to identify a good list of mosses and hepatics, these being the earliest records of the kind for the county. This boat has formed the subject of no fewer than forty monographs prepared by members of various learned societies, and Mr. Sheppard has in hand a descriptive handbook of this important object. A grey ware jar from North Lincolnshire has also been received, containing coins of the Emperors Valens, Julian II., Gratianus, Valentinianus, and Constantinus II., all of the fourth century A.D., with a curious ring bearing an image of the dove and olive branch, probably of Christian origin, and dating from the fifth century. The museum has also been fortunate in acquiring two important collections of birds, one that of Mr. Fortune, of Yorkshire birds, occupying forty cases; the second that of Sir H. Boynton, from Burton Agnes Hall, in 200 large cases. Both these important collections are now being catalogued and arranged for exhibition.

MR. W. C. FARABEE reprints from the Proceedings of the American Antiquarian Society for October, 1909, an account of the strange race known as the Machyengas, who inhabit the region lying between the base of the Cordillera and the Upper Ucayaali and Urubamba rivers in eastern Peru. The most remarkable fact about them is that they have no fear of the dead, and do not hesitate to touch the corpse and dispose of it without any ceremony, simply flinging it into the river to be eaten by fish. This results from the absence of any belief in the return of the soul, which after death enters the red deer. This animal, though not regarded as sacred, is not used for food. When asked what becomes of the spirit, they reply, "Nothing; that is the end of it when it enters the deer." Their deity Idioci, "the big man of the sky," is otiose, and has little concern with the world except that he thunders and sends rain. He is treated with indifference, receiving no prayers, offerings, or dances; they have no charms or fetishes, and are controlled by no power or influence outside themselves. This is a remarkable picture of a tribe bound by no conventions or restraints of religion or custom.

THE Bulletin of the Sleeping Sickness Bureau (No. 19, July 26) contains a progress report on the Uganda sleeping-sickness camps from December, 1906, to November, 1909, by Dr. A. P. Hodges, principal medical officer. It deals particularly with the treatment of the disease. The conclusions are that the prospect of curing sleeping sickness by medicinal treatment has not materially increased, that the percentage of apparent cures is practically negligible from the point of view of stamping out the disease, that the percentage of apparent cures continues to diminish with lapse of time after treatment, while the death-rate continues to increase, and that there is no decided superiority of one mode of treatment over another of those known to be of benefit.

THE July number of the monthly *Folia Neuro-biologica* thoroughly maintains the reputation of that magazine for usefulness as a bibliographical review of neurology. Of the three original articles contained in this number, perhaps the most interesting is a paper by Dr. Ferruccio Rossi on the cutaneous innervation of the lumbo-sacral region in the dog. The author concludes (1) that spinal transection at various levels in this region reveals very precise limits between cutaneous sensibility and insensibility; (2) that these limits are constant and characteristic for each segmental level; (3) that transection between the 13th dorsal and 1st lumbar, between the 1st and 2nd, 2nd and 3rd, or 3rd and 4th lumbar segments involves only a single *dermatom*, while yet more distal transections involve more than a single *dermatom*; (4) that the results obtained are of value for the study of the dorsal and ventral axile lines of the extremities, and for the topical diagnosis of spinal lesions.

To the Bulletin of the Royal Academy of Belgium, Classe des Sciences, 1910, No. 5, Mr. A. Rutot contributes an article on the existence in Belgian caverns of layers containing remains of Arctic rodents. Such layers have been already identified in Swiss and German caves in association with those containing the so-called mammoth-fauna, which indicates a moderately cold climate, and includes the Aurignacien and Solutreën stages. One of these rodent zones—the Middle Magdalenien—contains a fauna comparable to that of the European and Asiatic steppes, while a second includes one of the type of the Siberian tundra. Both these layers belong to the reindeer epoch; but the tundra-like fauna alone indicates absolutely Arctic conditions, *Myodes torquatus*, *Arvicola gregalis*, and *Lagomys pusillus* representing the Arctic type of rodents. The researches of the author reveal the interesting fact that almost precisely identical faunistic, and therefore climatic, conditions obtain in the caverns of the Meuse valley and other districts in Belgium, where, however, the Solutreën stage is practically unrepresented.

ACCORDING to the *Field* of August 3, no fewer than nine "schools" of caa'ing whales, *Globicephalus melas*, were observed out at sea by some men occupied in capturing seafowl on the bird-rocks at Vagö, in the Færöes. Of these, 250 were surrounded by the boats and driven into Midvag, and killed the same evening. The next morning, when the take was being distributed, news came that another very large school had made its appearance at Sand, some twelve miles distant, but that no attempt at driving them towards the land had been made, the number of boats present being inadequate for the purpose. Many of the Midvag people at once started for the spot, and as a result of the combined attack which ensued 400 more whales were secured. The value of the products of a whale of this species is about 3*l*. 7*s*. 6*d*.

THE *Emu* for July contains an excellent coloured plate of the white-fronted fantail (*Rhipidura phasiana*), a species first described by Mr. de Vis in 1884, on the evidence of a specimen collected near the mouth of the Norman River. In addition to a portrait of the late Dr. Sharpe, this issue also includes various papers on Australian bird-life, chiefly of local interest.

IN part i. of vol. xl. of the Memoirs of the Museum of Comparative Zoology at Harvard College, Mr. Glover M. Allen gives coloured figures of living specimens of that rare insectivorous mammal *Solenodon paradoxus* of San Domingo, based on living specimens recently received by that institution. These show that the general colour is some shade of tawny or rufous, with a variable amount of black on the back and throat, and a pale nuchal spot. They further indicate that the well-known figure of the other species of the genus, *S. cubanus*, given by Peters is incorrect in showing the tail bent laterally, this appendage being incapable of such lateral movement except near the tip. The two species were formerly believed to be distinguished merely by colour, but it is now ascertained that there is a difference in the number of the vertebræ. Much information with regard to the skeleton, muscles, and viscera is given in Mr. Allen's memoir.

A STUDY of the distribution of the Mollusca in connection with an ecological survey of a marsh area on the Chicago River is discussed by Mr. F. C. Baker in a Bulletin (vol. viii., art. 4) of the Illinois State Laboratory of Natural History. The author is especially concerned with showing how ecological observations may throw light on the taxonomic relation of species.

MR. S. T. DUNN places on record in the *Kew Bulletin* (No. 6) a historical account of the Hong Kong herbarium, in which he duly acknowledges the valuable services of Mr. C. Ford, who was for thirty years curator, and of Sir Joseph Hooker, whose latest assistance has been rendered in the form of a personal revision of the balsams. The miscellaneous notes in the same number of the journal contain several interesting items, including a letter from Mr. H. N. Ridley describing the botanical features observed on a journey to the north-west of the Malayan peninsula, where he traced the change from a Malayan to a Siamese flora about Gunong Terai; a collation of data concerning the germination of the rubber-yielding species *Manihot dichotoma*, *M. piauhyensis*, and *Funtumia elastica*; also a communication regarding the Guayule industry in Mexico.

AN article on the genus Citrus, contributed by Mr. A. W. Lushington to the *Indian Forester* (June), claims attention both as a systematic revision of a difficult genus of cultivated plants, and because the author attempts to identify the plants yielding the numerous Indian varieties of citrus fruit. Four classes or subgenera are defined. Firstly, there is *Citrus trifoliata*, regarded as the most primitive. Then there are the species bearing four-petalled flowers, and presenting other typical characters, represented by the caffre, sour and sweet limes. A third class is characterised by five-petalled flowers, usually white, and a fruit with a loose skin, of which the mandarin is an example; while the fourth class includes the pomelo, lemons, Seville orange, and citron, which agree in the production of a fruit with a firmly adherent skin and flowers normally five-petalled.

A CORRESPONDENT informs us that he recently found growing on the cliffs near Osmington, Weymouth, among a large quantity of ordinary blue chicory, several plants

which bore white flowers corresponding in every respect with the ordinary chicory except in colour. Though this is an uncommon occurrence, the white variety of the common chicory has been recorded before. Syme in "English Botany" (v., p. 123) gives the colour as "pale bright-blue varying to white," and Hooker, "Students' Flora" (p. 210), says flowers "bright blue, rarely white."

THE summary of the weather issued by the Meteorological Office for the summer season comprised by the thirteen weeks from June 25 to September 3 shows that the mean temperature was rather below the average except in the north and west of Scotland, but the difference from the normal was nowhere large. The absolute maximum temperatures ranged from 80° to 83° in all the districts of the United Kingdom with the exception of the north and south of Ireland and the Channel Islands, where the highest temperature was in each case 79°. The lowest shade temperatures ranged from 30° in the east of Scotland and 34° in the north of Scotland and the south-west of England to 40° in the Midland counties, 41° in the south of Ireland, and 47° in the Channel Islands. The largest aggregate rainfall was 13·71 inches, in the west of Scotland, and the lowest 6·81 inches, in the east of England. There was an excess of rain over the entire kingdom except in the north of Scotland, the greatest excess being 2·77 inches, in the south-west of England. The number of rainy days ranged from eleven more than the average in the south of Ireland to five less than the average in the north of Scotland. The largest number of rainy days in any district was sixty, in the south of Ireland, and the least forty-four, in the south-east of England. There was a deficiency of bright sunshine for the thirteen weeks in all districts except in the north of Scotland and the north of Ireland. The greatest deficiency was 135 hours in the Channel Islands, 126 hours in the south-east of England, and 113 hours in the north-east of England. At Greenwich the mean temperature for the three summer months this year was 1° below the average, the mean being 61°. The absolute maximum temperature was 82·3°, which is decidedly low in comparison with former summers, and there were forty-three days with a temperature of 70° or above, which is a rather larger number of warm days than some recent summers. The aggregate rainfall was 8·10 inches, which is 1·32 inches more than the average, but is less than in the summer of either 1908 or 1909. The deficiency of bright sunshine at Greenwich for the three months was 170 hours.

THE meteorological chart of the North Atlantic and Mediterranean for September (first weekly issue, August 18), published by the Meteorological Committee, gives an interesting account, with daily synoptic charts, of the weather over the Atlantic for a week ending August 17, and throws considerable light on the cause of the changeable weather over the British Islands during that period. Between August 11 and 14 a barometric depression passed slowly from about 55° N., 30° W., to the neighbourhood of our western coasts, causing showery weather generally over western Europe, and thunderstorms in many parts of the United Kingdom on the night of August 14. During the latter half of the period another depression developed over eastern Canada, and furnished a good example of such disturbances crossing the whole of the North Atlantic. It arrived off the west of Scotland by the morning of August 17; changeable weather therefore again set in, and south and south-west winds became strong on parts of our western and southern coasts.

THE director-general of Indian observatories has issued a memorandum, dated August 6, on the monsoon conditions prevailing during June and July, with anticipations for August and September. The combined distribution of rainfall in June and July was rather irregular, being considerably in excess in some provinces and in defect in others. In July the monsoon conditions were weak over a large area, and an almost complete break in the rains occurred in the second and third weeks. From information obtained as to the conditions over a large part of the earth's surface since the date of the memorandum of June 9 (see NATURE, July 28), the director-general concludes, *inter alia*, that the general outlook appears more uncertain than usual, but there is no reason for expecting a large defect in the total amount of rainfall during August and September.

THE *Annuario* of the Rio de Janeiro Observatory, 1909–10, contains, in addition to ephemerides and astronomical data for the two years stated, a large number of tables relating to the physics of the globe. The tables usually employed in the reduction of astronomical and meteorological observations, and the values of the various units are very complete and handy for reference. The compilation extends to 405 octavo pages, but contains no original scientific discussions.

Le Radium for July devotes seven pages to tables of constants of ionisation and of radio-activity compiled by Prof. T. H. Laby. The following constants are tabulated:—Rates of re-combination of ions, their mobilities, the electric charges they carry, the quotients of the charges by the masses, path and velocity of α rays, number of α particles emitted by radium, heat developed by radio-active substances, and a number of other radio-active and atomic constants which may be calculated from these. In the same number M. W. Duane, of Madame Curie's laboratory, gives a description of an arrangement for registering photographically the number of α particles emitted by a radio-active substance, founded, like the counting method of Prof. Rutherford and Dr. Geiger, on the augmentation of the ionisation of a rarefied gas within a closed vessel by the collision of the α particles with the molecules. The vessel, of small capacity, is of ebonite, closed below by a brass plate having a small window in it covered with a thin sheet of mica. The radio-active substance is placed below the window, and the brass plate is raised to an electrical potential nearly sufficient to cause a discharge to take place between it and a wire electrode at the top of the vessel, which is connected to a gold-leaf electroscope. An image of the gold leaf is formed on a photographic film moving behind a slit. The gold leaf is brought back to the normal position after each displacement by means of a leak produced by polonium outside the electroscope. Several reproductions of photographs obtained are given, which show the displacements produced by the α particles, but the author gives a further photograph showing displacements obtained without α particles, the explanation of which he is not yet in a position to give.

THE current number of the *Zeitschrift für physikalische Chemie* contains another contribution from the van 't Hoff Laboratory at Utrecht on the allotropy of the elements, the alleged allotropy of lead having been examined by E. Cohen and K. Inouye. During the electrolysis of solutions of lead salts, it was shown by O. Lehmann that two kinds of crystals can be formed according to the conditions, one crystallising in the regular and the other in the monosymmetric system. It has now been found that cells set up with these different crystals show no difference

of electromotive force, from which it is concluded that these two crystalline forms are not really allotropic modifications.

THE July issue of the Journal of the Association of Teachers in Technical Institutions has reached us. Its leading contents include the address of the president of the association, Mr. J. Wilson, in Birmingham last June, and an address delivered by Dr. Robert Pohl to the west Yorkshire branch of the association last April. Both these discourses have already been dealt with in these columns.

THE Cambridge University Press gives notice that it has taken over the copyright and control of the "Encyclopædia Britannica," and that it will publish the new and complete edition (the eleventh) about the end of the present year. The work entirely supersedes all previous editions, and brings its survey down to the summer of 1910. The whole of the twenty-eight volumes will be issued at one time, in two forms, an ordinary paper impression and one on India paper. To many readers the thin paper edition will come as a great boon.

THE Geologists' Association announces that its jubilee volume, "Geology in the Field," is now completed, and that an index to it is in preparation, and will be issued shortly.

OUR ASTRONOMICAL COLUMN.

REDISCOVERY OF D'ARREST'S COMET (1910c).—A telegram from the Kiel Centralstelle announces the rediscovery of D'Arrest's comet, by M. Gonnessiat, on August 26. The comet is of the fourteenth magnitude, and its position at 9h. 32·6m. (Algiers M.T.) on the day of discovery was R.A. = 16h. 48m. 25·3s., dec. = 9° 42′ 50″ south; this position lies in Ophiuchus about 5° E. of ζ Ophiuchi.

This comet was discovered by D'Arrest in 1851, and has a period of about 6·5 years. In 1903 it escaped observation, but was observed, after passing perihelion on May 21, in the summer of 1897.

An ephemeris for the comet is published in No. 4437 of the *Astronomische Nachrichten* (p. 344). The observations indicate that corrections of −1m. 17s., +5·1′, should be applied to M. Leveau's ephemeris (*Bulletin astronomique*, vol. xxvii., p. 81), and the following places result:—

Ephemeris oh. M.T. Paris.

1910	α (h. m.)	δ (° ′)
September 9 ...	17 23·8 ...	−16 53·4
,, 11 ...	17 35·4 ...	−17 53·1
,, 13 ...	17 42·3 ...	−18 52·0
,, 15 ...	17 49·4 ...	−19 49·2

Owing to the low declination and the fact that the magnitude is only 14, observations in these latitudes are not very promising.

THE RECENT OCCULTATION OF η GEMINORUM BY VENUS.—Observations of the occultation of η Geminorum by Venus on July 26, made at several observatories, are reported in No. 4435 of the *Astronomische Nachrichten*. MM. Baldet, Quénisset, and Antoniadi found, at Juvisy, that the times of immersion and emersion were 15h. 2m. 9s. ± 2s. and 15h. 5m. 39s. ± 0·5s. (M.T. Paris) respectively, the duration of the occultation being 3m. 30s. ± 2·5s. A notable feature of the emersion under good conditions was the suddenness with which it took place; within 1½ or 2 seconds from the first suggestion of reappearance, the star regained its normal brightness. Apparently the rays were not deviated more than 0·3″, and there was no change in the colour of the star. From the fact that the augmentation of the star's light extended over 1½ or 2 seconds, the observers deduce that the height of the planet's atmosphere, producing the absorption, is about 80 to 110 km.

SEARCH-EPHEMERIDES FOR COMETS 1889 V. (BROOKS) AND 1890 VII. (SPITALER).—A set of elements and a search-ephemeris for Brooks's comet, 1889 V., are published in No. 4437 of the *Astronomische Nachrichten* by Dr. Bauschinger. The probable time of perihelion passage is 1911 January 8, and the ephemeris covers the period August 4, 1910, to February 20, 1911. This comet is of special interest owing to its having thrown off four fragments, one of which became brighter than the parent body, in 1889. Seen in 1903, it was single and of the fourteenth magnitude, so that its detection at the coming approach is doubtful. According to the ephemeris, the comet was at its nearest to the earth at the beginning of August, and its present position (September 9) is in Sagittarius at α = 19h. 37·4m., δ = −29° 55·2′ south.

The rediscovery of Spitaler's comet is still more doubtful. Discovered in 1890, its period was found to be about 6½ years, but it was not seen in 1897 or 1903. However, Herr F. Hopfner has calculated elements for the present approach, and publishes them, with nine four-day search ephemerides, in No. 4437 of the *Astronomische Nachrichten*. The different ephemerides are calculated for different dates of perihelion passage covering the period September 12 to November 15 in eight-day intervals.

THE SUN-SPOTS OF 1909.—A statistical summary of sun-spots, as observed at the Royal Observatory of Capodimonte during 1909, is published by Dr. E. Guerrieri in No. 6, vol. iv., of the *Rivista di Astronomia* (Turin). In it are given numerous tables showing analyses, in different forms, of the frequencies, areas and numbers of spots, faculæ, &c., which should prove useful to anyone discussing solar phenomena. The mean diurnal frequency of spot groups for the year was 3·6, 1·7 less than that for 1908; the mean diurnal number of spots was the same, 30·5 in each year.

WATER VAPOUR ON MARS.—The conditions obtaining on Mount Whitney during the Lick Observatory expedition researches in September, 1909, are discussed by Prof. Campbell in No. 3, vol. iv., of the Journal of the Royal Astronomical Society of Canada (p. 212). Prof. Campbell combats the idea that they were unfavourable, and says that on September 1 and 2, when the photographs were taken, the nights were as perfect for the purpose as could be wished. He also points out that with a nearly evanescent *a* band, the more water vapour one attributes to the terrestrial atmosphere, the less remains attributable to that of Mars.

MEASURES OF DOUBLE STARS.—Dr. Lau's tenth list of double-star measures appears in No. 4436 of the *Astronomische Nachrichten*. It contains the places, recent measures, and the colours of 122 Σ and 6 OΣ stars, and in some cases the formula giving the nature of the variation in distance and position-angle. It is not without significance, perhaps, in the discussion of the colours of double stars, that, in the majority of cases, where both stars have the same colour the colour is given as "white"; where they differ, the colours are most often complementary.

THE PERMANENT INTERNATIONAL COMMITTEE FOR THE "CARTE DU CIEL."—We have now received the volume giving an account of the meeting of the permanent committee for the execution of the *Carte photographique du Ciel*, which took place in Paris in April, 1909. The volume gives a list of those who attended, and a detailed account of the discussions and resolutions; but as the meeting was reported at length in our issue of June 10, 1909, there is no need to refer further to its proceedings.

METEORS AND BOLIDES.—No. 1, vol. iv., of *Palaestra*, a monthly journal issued at Asti, Italy, contains an interesting paper by Prof. Guido Cora on meteors and bolides. The paper was suggested by the appearance of a remarkably fine bolide at Casalbordino (Abruzzi) on December 3, 1909, and contains a discussion of the appearance, the frequency, and the general phenomena attending the appearance of meteors.

HISTORY OF NAVIGATION.—An interesting article on the determination of position at sea, written by Prof. Marguet,

appears in No. 13 of the *Revue générale des Sciences*. The author discusses the histories of the compass, the log, and astronomical determination, paying particular attention to such matters as the difference between the magnetic and true north, and illustrating his descriptions with cuts of instruments such as the astrolabe and arbalestrille.

METEORIC FIREBALLS.—The Rev. W. F. A. Ellison, of Fethard Rectory, Waterford, reports that on August 28, at 11h. 29m. G.M.T., he was surprised by a very brilliant flash, which on first thought he supposed to be vivid lightning. Instantly looking upwards, however, he saw a bright meteor-streak extending from 330°+35° to 125°+75°. It was fully half a degree wide, and part of it remained in sight three or four minutes, and drifted several degrees to the west.

Mr. Ellison has been very successful in recent years as an observer of fireballs, and describes this one as an exceptionally grand example. Unfortunately, he did not see the direction of its flight, but the radiant must have been either in Sagittarius or the head of Ursa Major.

The Rev. J. C. W. Herschel, at Wellington College Station, Berks, saw a splendid Perseid on September 2 at 9h. 5m. p.m. It passed from near the Polar Star to θ Draconis, crossing β Herculis, and vanishing in the region of Ophiuchus. The duration was about three seconds, and the meteor projected a streak along the greater part of its course. The probable radiant was near ϵ Persei, and the height of the object from about 72 to 44 miles over Wellingboro' to Yeovil. Its visible trajectory covered 125 miles at a velocity of about 41 miles per second.

Further observations are, however, required of these fine meteors before trustworthy heights and velocities can be computed.

RECENT HITTITE DISCOVERY.

THE object of the lecture is to show in outline how the memory of the Hittites as an imperial people has been recovered and what their place in world-history was. This recovery dates from the finding in 1834–45 of two prehistoric cities at Boghaz Keui and Uyuk in north-western Cappadocia. Their sculptures and inscriptions were ultimately recognised by Sayce as belonging to the same family as certain inscriptions and sculptures which had been found at Hamath and elsewhere in Syria after 1870, and also some other monuments observed in Asia Minor at Ibriz and near Smyrna. These Syrian monuments had been already ascribed to a people which, under the name of *Kheta* or *Khatti*, played a large part in the Syrian relations of Pharaohs of the XVIIIth to the XXth Dynasties, and in those of the Assyrian kings; and this people, it was generally agreed, was identical with the "children of Heth" or Hittites of the Old Testament. If the latter were responsible for the monuments in question in Syria, then, too, in some sense, they were responsible for the monuments in Asia Minor; and, in any case, it was clear that a very peculiar and important civilisation, covering a large area of the Nearer East in the Second Millennium B.C. and the early part of the first, had been forgotten by history.

Scholars and explorers made continual efforts during the next quarter of a century to elucidate this civilisation, and succeeded so far as to place its origin in Asia Minor, and to fill up, more or less, by the discovery of many new monuments, the geographical gaps dividing those first observed. They found that these lay, roughly, along lines of communication leading from north-western Cappadocia to the south and west, and they established in fact that not only northern Syria but west central Asia Minor showed such monuments in almost every part. But fundamental questions—who were the authors of this civilisation? where precisely was its chief focus? and who shared its development?—had still to be left open; and it was not until Boghaz Keui came to be excavated by Winckler and his companions in 1906–7 that they could be answered.

At the last-named site, known for some years to produce cuneiform tablets partly in Babylonian, partly in an unknown tongue, the excavators explored a large megalithic group of ruins in the lower city and fortifications and certain other structures in the upper, besides clearing and re-examining the long-known religious rock-reliefs of Iasily Kaya. Besides several mural sculptures, of which the most interesting shows an armed Amazon, the explorers came on a number of cuneiform tablets, chiefly in the ruins of the earlier portions of the lower megalithic building, which was evidently a palace. These tablets proved to be in the main Foreign Office archives of six generations of kings, who ruled over the Hatti of Boghaz Keui in the fourteenth and thirteenth centuries B.C. They conclusively prove that the Hatti of Cappadocia were the *Kheta* who fought with Egypt at Kadesh, and made the famous treaty with Rameses the Great. The first important reign was that of Subbiluliuma, contemporary of Amenhotep IV.; the last was that of Hattusil II., the "Khetasar" who made the treaty with Rameses. But we know from Babylonian, Assyrian, and Egyptian records that, both before and after these kings, the Hatti were a power in western Asia, and we have to credit them with a history of at least a thousand years. The tablets show that Subbiluliuma extended Cappadocian power over north Syria and even over great part of Mesopotamia, where the Mitanni had formerly been dominant; and that this wide dominion, extending even to the Babylonian frontier, was preserved by his chief successors, Mursil and Mutalla, and not lost until after the reign of Hattusil II., who treated with both Egypt and Babylon as an equal. Startling as this revelation is, we now see that without the existence of such a Hittite power the wide distribution of the Hittite monuments, civilisation, and physical type would have remained inexplicable; and we recognise in Boghaz Keui the natural focus from which these radiated over Asia Minor and Syria. But we recognise also that many of these monuments and much of the Hittite civilisation were work of other peoples than the Cappadocian Hatti—peoples who had learned of the latter and in many cases outlasted them. Other phenomena, too, are explained by the revelations at Boghaz Keui, notably the failure of the Ægean power of Crete to effect a lodgment in Asia Minor, and the long continuance of the Hittite name and fame in Syria. Moreover, they account, as nothing else can, for the Oriental influence which acted on the earliest Hellenic civilisation, especially in Ionian art and religion. For not even the early contact between the Muski-Phrygians and Assyria appears to have resulted in sufficient orientalisation in Phrygia and Lydia to explain the Greek phenomena. The real distributing agency of Orientalism was in Cappadocia, the art and religion of which were of the required type.

It is evident, then, that a great, if forgotten, part has been played in the relations between East and West by the civilisation which occupied so long the whole land bridge between Asia and Europe. The long survival and great extension of Hittite influence in Syria has been illustrated by the excavations at Sinjerli and Sakje Geuzi, and by recent discoveries in the basin of the middle Euphrates on both sides of the river. But an immense field remains to be explored, and other important sites must be thoroughly examined, notably Carchemish, Marash, and Malatia. When even one of these is dug according to the best modern methods a flood of light will be thrown on Hittite archæology; and with the help which the decipherment of the Boghaz Keui tablets not in Babylonian will afford to the decipherment of the Hittite inscriptions, already phonetically interpreted in no small measure by Sayce, the study of the Hittite civilisation will take its place in the field of scientific history.

[1] Discourse delivered at the Sheffield Meeting of the British Association by D. G. Hogarth.

THE INTERNATIONAL ZOOLOGICAL CONGRESS AT GRAZ (AUGUST 15–20, 1910).

THE eighth international congress of zoologists has been a most enjoyable one, even though it has not been marked by any striking pronouncement. No president could have carried out the arduous duties of his office more successfully than Prof. von Graff. To him in a large measure was due the representative character of the meeting. The committee under his presidency worked hard to ensure the comfort of the visitors and the smooth conduct

of the meetings. That this was no small task may be judged from the fact that some five hundred members and participants came to Graz on August 14 and 15, and that in the five days of the congress more than 100 papers had to be read. One disadvantage of this abundance of communications was the limitation of discussion, which might have been surmounted had the members exercised the art of compression. As it was, papers were frequently read *in extenso*, and valuable time was thus lost. Some confusion was caused by the carrying over of papers from one day to the next, but the committee must be congratulated on the manner in which they organised the proceedings and surmounted difficulties, which in most cases were caused by the very success of the congress.

For such an international gathering Graz was a fortunately chosen meeting place. This "pearl of Styria" lies in beautiful scenery, and wears a peaceful and picturesque air. The Stadt-Park and the Schloss-berg form convenient shady spots in which the leisurely life of the town can be studied, whilst in the "Hilmteich" woods, the methods for bird-protection are seen in the most modern form. Gatherings at these and other points were arranged during the intervals of congress-business, and were greatly enjoyed, for, with the exception of two evenings, the weather remained fine.

The meetings themselves took place in the large "Stephanien-Saal" in the mornings, and in the university buildings in the afternoons. On the first day (August 15) the congress inspected the university, and more especially the zoological institute, where President von Graff guided the members over the charming building over which he rules. Then followed the official reception and opening of the congress. The only papers read that day were a long discussion by Prof. Delage on the methods and results of experimental parthenogenesis; a kinematographic representation of sea-urchin development (by M. F. Vlés and Mdlle. Chevroton); and a description of the biology of the lower Danube by Dr. Antipa. A pleasant evening was spent at the Hilmteich, where one realised the truly international character of this gathering.

The most important paper given during the second day of the congress was one by Prof. Gaupp, of Freiburg, on the affinities of the mammalia as deduced by the study of the skull. Dr. Gaupp is, of course, a well-known authority on this subject, and he treated it from a broad comparative standpoint. Stress was laid on the primordial or cartilaginous cranium, and the descriptive part of the paper was illustrated by a series of exquisite models made by Ziegler under the supervision of Gaupp and others. Amongst many detailed points of interest was the fact that the gristly skull of the young rabbit presented a closer agreement with that of the lizard than did the skull of Echidna. The relationships of the Mammalia, so far as the primitive skull was concerned, pointed rather to reptilian than to amphibian ancestry. Dr. Gaupp subsequently gave a series of demonstrations of the models used in his lecture.

Another paper of importance was that by the veteran zoologist, Geheimrath F. E. Schultze, on the air-sacs of birds, illustrated by a series of casts of the lungs and air-sacs taken from a number of representative and familiar birds. These models were exhibited during the course of the congress, and formed a triumph of technique. They consisted of metallic castings, and exhibited the relationships of the different sacs by a carefully chosen system of colours. No such clear demonstration of the anatomy of this difficult subject has ever before been carried out.

During the afternoon of each day the congress divided into eleven sections, thus showing the extent to which specialisation has proceeded in zoology. The cytologists and protozoologists constituted the first of these, and the chief subjects of interest in this section were the nature of the cell-elements, particularly the meaning of the chromosomes and their relation to sex. These papers, however, were of a highly technical character, and are difficult to summarise until the printed report appears. Very few papers on Protozoa were communicated, the most interesting being one by Dr. Enriques on the experimental determination of conjugation among Infusoria, and a long discussion by Dr. Hartmann on the nature of the nucleus in Protozoa and the bearing of this subject on general cytology.

In the second section papers were given on the anatomy and physiology of Invertebrata. Prof. Pelseneer led off with an interesting account of the occurrence of hermaphroditism in Lamellibranchs, and traced a relation between this condition and certain bionomical factors. It appears that hermaphrodite forms are much commoner than is generally supposed, especially among bivalves that are either commensal in habit, or that lead a deep-sea life. Another paper of interest was that by Mr. E. Ray Gregory on the water vascular system of one of the cake urchins (Echinarachinus). M. Rousselet exhibited specimens of Trochosphæra, and there were several papers dealing with purely histological topics. In the section devoted to Vertebrate problems, there were several contributions to the anatomy and development of the lymphatic system, including some beautiful demonstrations of the lymphatics in tadpoles by Dr. Hoger, in the cat by Drs. Huntington and McClure. Prof. Lee, of Minneapolis, exhibited a most valuable series of early stages in the development of Rodents peculiar to North America. Prof. Hubrecht described the placenta and early development of that strange Malayan mammal, Galeopithecus. Dr. Franz gave an account of the relation between motor activity and the development of the thalamencephalon in the development of fish; and Principal Jordan a most attractive description of the Bering Sea fur seal.

The most popular sections, however, were those that dealt with experimental and bionomical problems, and the list of papers read before them is so large that only a mere and arbitrary selection can be made. Of these, the paper on colour-physiology by Dr. Paul Kammerer, of Vienna, was the most interesting. For some time past Dr. Kammerer has subjected specimens of various Amphibia (*Salamandra maculosa, S. atra,* Molge, spp., *Rana esculenta, arvalis,* &c.), Reptilia, and Mollusca to the influence of various coloured surroundings, and has also reared the offspring of these animals under certain conditions of light and background. By the aid of coloured lantern slides, the author showed how the colouration both of the under and of the upper surface responded to this treatment, how the question of sex complicated the result, and how the offspring appeared to inherit a tendency to develop colouring similar to that induced in their parents without the influence of similar surroundings. The backgrounds employed were chiefly yellow earth and black earth, and the results were only broadly stated (the paper suffering, as did so many others, from congestion of business). Dr. Gadow, of Cambridge, made an interesting speech on the nature of Amphibian colouring, but further discussion was prohibited by the lateness of the hour. Subsequently Dr. Kammerer showed spirit-specimens of his experimental animals. A somewhat disappointing paper on a closely allied subject—the formation of pigment in birds—was contributed by Dr. Riddle, of Chicago. In this Dr. Riddle stated that "both the kind and quantity of melanic pigment produced by a bird . . . are dependent on nutritive and other local and temporary conditions." The disappointment lay in the fact that no explanation of what these conditions were, was given. The paper was mainly an attack upon the results obtained by Miss Durham on the pigments of guinea-pigs.

Prof. Woltereck contributed a further instalment of his work on Daphnids, and showed how variations in the body were correlated with sexual changes. On this subject Dr. Langhans, of Prague, also spoke, urging the evidence he had obtained as to the inheritance of acquired characters in this group. One of the longest experimental papers was that by Prof. Conklin on the power of regulation in Echinoderm eggs. After centrifuging such eggs for a short time, the cytoplasm of the eggs is drawn away from its initial position, but when the eggs are removed from the centrifuge the regulative power shows itself by causing a symmetrical arrangement of the cells. The diverse behaviour of the two polar cells was very clearly shown, and the influence of the length of time of centrifuging was also explained by a series of lantern slides taken from some two thousand preparations.

In another section, Prof. Crampton gave a well-illustrated account of the distribution of species of Partula, based upon his explorations in south-eastern Polynesia. He pointed out the extremely definitely localised character of the species and the evidence for mutation. In the same section, Prof. Carpenter, of Dublin, described an interest-

ing fossil Isopod from the Irish Devonian. Several other palæontological papers dealt with the problem of extinction, and with certain Annelids, Reptiles, and Insects.

Regarding the congress as a whole, one is struck by its increasing scope. It is attended not only by professional and amateur zoologists, but by anatomists, physiologists, and geologists. The problems it discusses touch upon questions of the greatest interest to pathologists and to sociologists. The experimental treatment of zoology is being increasingly adopted, whilst the older systematic problems are being studied afresh. The present is a time of data-collecting on an enormous scale, but no fresh principles are as yet forthcoming, and there is a marked tendency to confine the treatment of the subject to non-controversial matters. One comes away from Graz impressed by the huge amount of zoological work now being done, by the community of spirit that animates its devotees in all countries, and by the value to the cause of peace which such gatherings represent. These sentiments were emphasised in the speeches at the banquet which closed the congress.

THE THIRD INTERNATIONAL CONGRESS OF SCHOOL HYGIENE AT PARIS, AUGUST 2–7, 1910.

THE comparative abstention of German school-hygienists from the third congress was a regrettable feature, and considerably diminished its value from a scientific point of view. The preponderance of Latin influence led to much rhetoric in the sections, and the records of the congress are those of trends of opinion rather than of work accomplished.

The subjects set down for general discussion on the three working days of the congress were, in order:—(1) Uniformity of method in medical inspection; (2) instruction in sexual hygiene; and (3) the training and appointment of the school doctor. The first of these alone presented any general scientific interest. A problem awaiting solution is how to frame the records of inspection so that trustworthy statistics can be obtained by which the influence of varying environments can be compared and alterations from decade to decade satisfactorily established. The discussion was opened by Dr. James Kerr in a paper the value of which could not be overestimated. He postulated that the two aims of medical inspection (the remedial and the statistical) must be separately considered, for no medical inspection carried out on *all* children is ever likely to be done at public cost to such an extent that it can be of any great value for scientific purposes; when quantitative estimates or comparisons are made, even between schools in the same town or classes in the same school, the results are often not really worth the paper they are written upon. As the result of long experience, he stated that ultimately one is content with only spending as much time as is absolutely necessary on detailed examination, valuable for scientific purposes, and in only examining in such detail sufficient numbers of children to reduce any errors of experiment within such limits that the results will afford a trustworthy standard; the examination of all children in that way is quite unnecessary. For scientific work, he claimed it is best that each topic be examined as a separate problem on data carefully selected and carefully defined by each investigator, and that general inspection should be carried on merely with a definite practical aim of relief to children who present obvious or gross defects. Without this there is great danger of scientific progress being arrested, and the whole movement becoming a lifeless routine of collecting inaccurate and valueless records. It is to be hoped that Dr. Kerr's opinions as here expressed will receive due attention from the authorities in Whitehall, for it is indubitable that much of the work being done in the country at present is utterly unscientific, and has already become the lifeless routine that Dr. Kerr is desirous of guarding against.

The rest of the work of the congress was split up into thirteen sections and sub-sections. Comparing the discussions with those of the second International Congress of 1907 in London, two branches of general school hygiene stand out in which most activity has taken place during the intervening three years. These are physical education and open-air schools. In Section vi., which dealt chiefly with the latter, carefully collated facts were forthcoming which proved alike the wide extension of the movement and the uniform good results obtained without distinction of climate or race. It was Dr. Neufert, of Charlottenburg, who shadowed forth the future developments arising out of the experience gained in the open-air schools. Why should the advantages of the open-air school be limited to the debilitated and unhealthy? If good for them, it must be good also for the normal. All our schools must in future approximate to the open-air ideal, and more activity must take the place of the sedentariness which is now the rule. In connection with the question of activity, it is interesting to note also how the attention paid to manual training has grown during the past three years. Scarcely mentioned in 1907, its advantages are in 1910 independently pressed in many sections and from many points of view by various workers.

Dr. Mumford, of Manchester, dwelt upon its importance in developing the association centres in the brain, where the various sense organs are organised in relation to the combination and arrangement of the muscles. Herr Schrag, of Berne, pointed out the importance of manual training as a link between the various subjects in the curriculum. Prof. Blazek, of Austrian Poland, brought forward the results of ergographical investigations, demonstrating the effects of manual training in developing certain mental qualities of readiness and concentration, and Dr. Schuyten, of Antwerp, supported this with facts proving the effects in diminishing inattention of satisfying the motor needs of the organism.

In Section iv., on physical training, many communications of importance were read. Dr. Digby Bell, of the British Naval School of Physical Exercises, insisted upon the necessity of rescuing the subject from the taint of quackery which still hangs around it. M. Demeny, of Paris, introduced his new system of physical education founded upon continuous movement in opposition to the alternations of fixed contraction and relaxation of muscles upon which older methods are based; his paper was rendered more valuable by a demonstration upon a pupil, which certainly upon æsthetic, and in the writer's opinion upon physiological grounds, showed his method to be superior even to the Swedish movements, which at present hold pride of place in our systems.

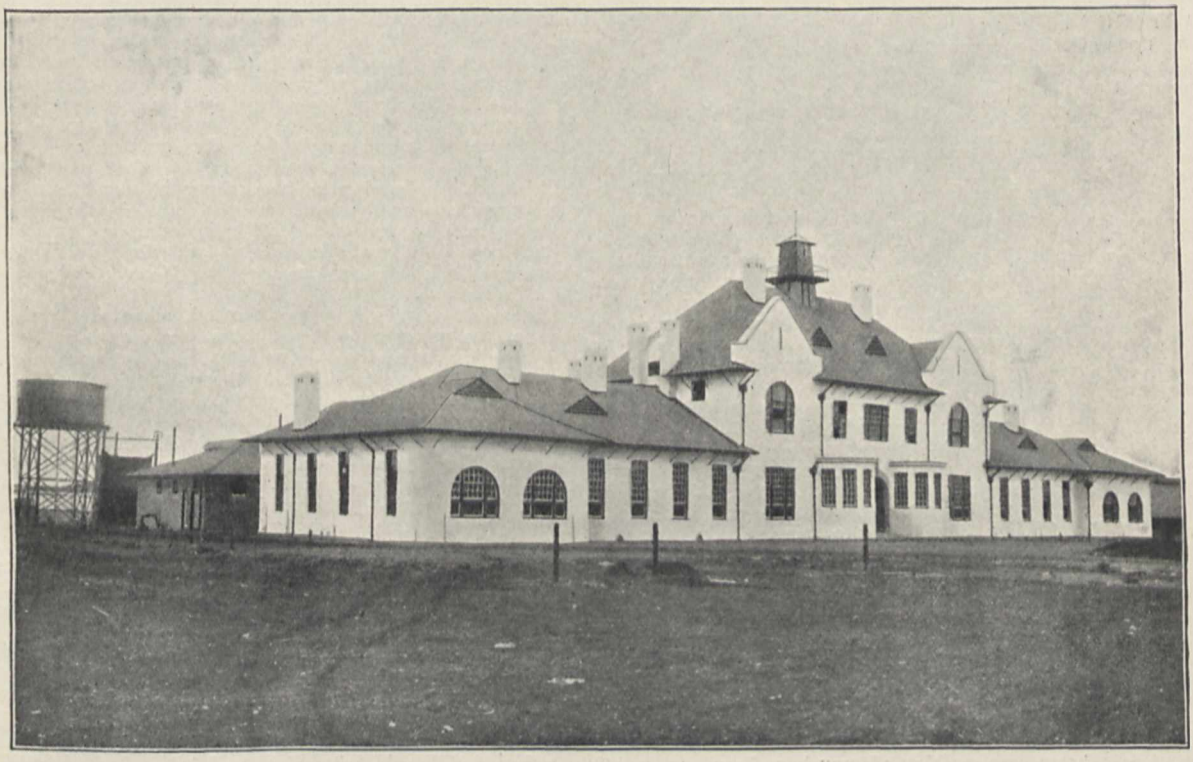
A question of great importance to medical inspectors is the discovery of a trustworthy mathematical formula which shall determine the state of nutrition of a child in relation to physical measurements. Prof. Guttmann, of Vienna, examined various formulæ, and came to the conclusion that the best is that of Bornhardt, viz. $G = BL/240$, where G = body weight, B = chest circumference, L = height, and 240 is a constant representing the mean of a very large number of measurements.

Amongst some valuable papers in Section ix. (teaching methods and syllabuses) was one by Dr. Janale, of Prague, giving the results of extensive investigations on fatigue in the school children of that city by Ebbinghaus's combination method, from which he concluded that a single long morning session *per diem* is superior to two shorter sessions occupying both morning and afternoon. Another was by Prof. Schuyten on "inattention" as measured in school over yearly periods by dynamometrical experiments accompanied by memory tests. In the first place, inattention is a natural and inevitable result of physiological activity. It is increased by defective conditions of sanitation and diminished by wise distribution of subjects in the time-table. The best results appear to be obtained by not mixing up together daily the various subjects in the curriculum, but by grouping together homologous subjects on each particular day. This is in direct opposition, of course, to the usual arrangement in school time-tables at present.

The congress, it will be seen, presented many features of great general interest, and its practical results will undoubtedly be considerable. It was satisfactory to hear from the lips of one of the Secretaries of State of France, at the concluding meeting, a pledge that the Government would carry into effective operation the proposals upon school hygiene already before the Chamber.

VETERINARY RESEARCH IN THE TRANSVAAL.

THE present veterinary bacteriological laboratories of the Transvaal Department of Agriculture are situated eight miles to the north of Pretoria, on a farm comprising altogether some 2000 acres of land. They were ready for occupation on October 1, 1908, but, before this time, research in South Africa had to be conducted under less favourable conditions. In 1898, a three-room building of wood and iron lined with brick formed the laboratory, and the equipment of this was "sadly deficient." Calf vaccine lymph was made here, but the preparation was suspended when the late war broke out in the latter part of 1899. In 1901, the laboratory, after having been used during the war as a stable, had now added to it a rinderpest station for the manufacture of serum, and by 1905 it had grown into a heterogeneous collection of buildings, mostly constructed from old wood and iron, from buildings destroyed during the war. Not only were the buildings unsuitable, but they were also unhealthy, enteric fever constantly occurring among the staff, so that in 1906 it was decided to establish the present laboratories.



Front View of the Veterinary Bacteriological Laboratories at Onderstepoort, Pretoria.

It may be of interest to consider the work done in these earlier years.

In 1896, rinderpest devastated S. Africa, thousands of cattle dying, and preventive inoculation was introduced. In 1898, at the old laboratory at Daspoort, calf vaccine lymph was made to vaccinate the Kaffirs when a serious outbreak of small-pox took place among them. In 1901–3, rinderpest serum was made in the Daspoort laboratory. In 1905, experiments were made which eventually resulted in the discovery of a serum for inoculating mules against horse-sickness. In 1902, at the close of the war, the introduction of East Coast fever, a new and devastating disease, took place; the disease was, however, at once studied, and means devised for preventing its spread.

A consideration of this work, then, shows what a practical character there had always been in the research work in the old laboratory, and we shall see that this is equally true of the new ones.

The present building comprises some three dozen different rooms, suitably fitted, each for its own particular object.

In the pathological laboratory, 1362 specimens were reported on in one year, and here is studied the histological pathology of various diseases, especially horse-sickness, East Coast fever, and other piroplasmoses.

In the zoological laboratory, the study of the entozoa of the sheep is a matter of great practical importance to the sheep-farmer. In another room, mallein, tuberculin, quarter-evil vaccine, and pleuro-pneumonia cultures are prepared. Three rooms are reserved exclusively for the preparation of rabies vaccine. In yet another room, the vaccine for blue-tongue and a horse-sickness serum are prepared. Of the former, 200,000 doses, and of the latter 1000 tubes, are sent out annually.

An entirely separate building is used for the preparation of calf lymph; three-quarters of a million tubes have been sent out into all parts of S. Africa during the last two years. The laboratory is evidently splendidly equipped with its centrifugal room, still room, serum store, animal room, operating theatre, post-mortem hall, museums, lecture rooms, &c., but we note one important omission, viz., a library, of which there is no account.

This, the commemoration publication, besides the historical account of the laboratory which we have abstracted, contains five papers. The first is by Dr. Arnold Theiler, the Government veterinary bacteriologist, and is on the very interesting and important subject of "Immunity in Tropical and Sub-tropical Diseases."

He gives an excellent and concise statement of the whole question. This article is worthy of a place in a commemoration number, but as regards the other papers, while in themselves good pieces of research work, there is no special reason for their appearance here. We miss any general account of the animal diseases of S. Africa, rinderpest, horse-sickness, heart-water, and so on; and we should have welcomed a general account and summary of the piroplasmoses and the mortality due to them. Nor do we find any general account of ticks, and the methods taken to combat them. We should have welcomed also a summary

of the state of our knowledge on animal entozoa and their economic importance.

The volume presents evident signs of haste in issue from the press. Some of the papers teem with misprints, some are characterised by an almost complete absence of punctuation, while again, in many instances, the language used and the construction of the sentences are so slip-shod as to render them almost meaningless. The volume has a number of excellent illustrations of the staff of the various departments, but the glazed paper on which the book is printed is very trying to the eyes. We may note, too, that on the title-page and cover the laboratories are called "the Veterinary Bacteriological Laboratories," though in the introductory chapter they are termed the "Veterinary Research Laboratories," a better term, we think, for, as we have seen, the work is by no means confined to bacteriology. The laboratory has, we feel sure, under its distinguished head a great future before it, and we venture to offer our heartiest congratulations on its new career.

HALLEY'S COMET.

A LARGE number of publications dealing with observations of Halley's comet have appeared during the last week or two, and from them we extract a few of the more important results.

Prof. Barnard, in No. 4431 of the *Astronomische Nachrichten*, deals with the observations he made during the time when the comet was at its least distance from the earth. The observations in the early morning were greatly interfered with by clouds and smoky skies, but the conditions were better after May 17. Prof. Barnard pays particular attention to the observations made during the early mornings of May 18 and 19, and directs attention to a bright pillar of a luminous character seen near the south-eastern horizon. The main feature was the rather broad beam of light, resembling the beam of a searchlight, which stretched obliquely from the eastern horizon to the Milky Way in Aquila, a length of 107°. Between 2h. and 3h. a.m. this was very conspicuous, and Prof. Barnard describes its dimensions and position with respect to neighbouring stars, showing that it was considerably inclined to the ecliptic. This is evidently the phenomenon referred to generally as the tail, but to the observers at Yerkes there appeared the other mass of luminosity, apparently quite separate from the beam, that extended to the south-eastern horizon. Not having been able to observe the comet regularly prior to August 18, Prof. Barnard hesitates to make a definite proposition, but he suggests that this phenomenon was the main tail, whilst the bright beam was only a separate streamer. It involved the ecliptic, and observations on August 19 showed it to be a real phenomenon connected with the comet; at 2h. 20m. a.m. it showed a more definite upper edge, bounded, roughly, by the stars β and γ Piscium and η and ζ Aquarii, and it joined the brighter beam near γ Pegasi. Observations made earlier in May showed several streamers, of which the long bright beam seen on May 18 may have been one, and they also indicated that on May 18 the breadth of the main tail should have been much greater than the beam actually was. Should Prof. Barnard's surmise prove correct, the evidence for the earth's passage through the tail about May 19 would be greatly strengthened.

Curious sky effects during May 19 were also recorded, and were unusual enough to suggest a connection with the comet. At noon, and for several hours afterwards, a horizontal bar of brilliant prismatic colours, with the red uppermost, was seen in the south at an altitude of about 20°, and around the sun was a prismatic halo of 22° diameter.

After its passage, the comet was a brilliant object at Williams Bay, and to Prof. Barnard "it far exceeded all expectations as a spectacular display." On May 26 the tail could be traced to a distance of 63°, and for 25° of its length was very conspicuous. On May 20 the head was about $\frac{1}{3}$° in diameter, and appeared like a nebulous star with a yellowish colour, but on May 24 it was recorded as bluish-white. On this date, however, there was apparently a double nucleus. To the naked eye and with opera-glasses there appeared a nucleus of sensible diameter and of a beautiful bluish-white colour, whilst in the 5-inch finder this was seen to be but an intense nebulosity surrounding a smaller, well-defined nucleus of eighth or ninth magnitude, and of a decidedly yellow colour. Thus naked-eye and telescopic observations on that date would refer to two different nuclei of opposite colours. For several nights about May 27 the tail appeared to diffuse northwards as high as Jupiter, and on a photograph taken on June 6 it is seen that the comet had discarded its tail, which was drifting away from it, and had formed a new one at a slightly different position-angle.

In the same journal Herr Sykora records an observation of the comet on the solar disc at 20·95h. (M.T. Tashkent) on May 19. A 13-cm. image of the sun was projected, and the comet was seen, like a finger-mark on paper, with a diameter of 1 cm.; during the three minutes that observations were not prevented by clouds, the relative motion of the supposed cometary image was about 0·5 cm.

Dr. Hartmann also contributes a note on the measures of the surface brightness of the comet made at Sonnwendstein. First he suggests that, instead of such indefinite terms as "bright," "faint," &c., a definite scale of standardised surface-brightnesses should be employed, the standard unit being referred to a definite illumination produced by a standard lamp under defined conditions. This unit is called a *phos* (*ph.*), a thousandth part of it a *milliphos* (*mph.*), a millionth part a *microphos* (*mkph.*); for the multiples the prefixes *kilo-* and *mega-* are suggested. Then he describes a method of using the photometer where the image of the object is seen through a hole pierced in a mirror fixed in the focal plane of the objective. By measured variations of the source of illumination, the surface of the mirror is brought to the same brightness as the focal image of the object. Again, by using suitable screens, the different radiations from any object may be directly compared, and for Jupiter Dr. Hartmann finds a range from red to green of 27 to 68 mph. (milliphos).

The results obtained by this method, comparing various parts of the comet on different dates, are very interesting. They are too numerous to give fully here, but one or two examples will serve to illustrate them. May 23, 9h. 2m. (M.E.T.), mean brightness of nucleus and the surrounding area of 22″ diameter: white, 220 mkph., yellow, 180 mkph., green, 410 mkph.; 9h. 27m., nucleus alone: white, 620 mkph., red, 360 mkph., orange, 630 mkph., yellow, 730 mkph., green, 1350 mkph. On May 26 a number of observations, including the nucleus, the area surrounding it, and the tail, were made, and for the tail, at 3m. 42s. in R.A. behind the head, a value of 0·22 mkph. was found. For comparison, Dr. Hartmann found on May 31 that the surface brightness of the Ring Nebula was 1·2 mkph., and for the inner space 0·6 mkph.; a bright area of the Milky Way, in Cygnus, gave a value of 0·05 mkph.

M. Antoniadi suggests that the tail, seen by Prof. Eginitis, turned towards the sun on May 20, was only a minor sheath; his observations, and those of Dr. Hartmann and others, show the tail as a sickle-shaped object with its *convex* side turned sunwards.

That the comet was a fine spectacle at Tokio is shown by a table giving the magnitude, length of tail, &c., as seen by Mr. K. Saotome, of the Tokio Observatory, reproduced in the *Astronomische Nachrichten*.

In No. 4433 of the same journal Drs. Cowell and Crommelin discuss the different elements published by various calculators for the 1910 osculation. These agree fairly well except in the value given for the mean motion (μ), in which there are grave differences. M. Iwanow adopted Pontecoulant's value for 1835, which the Greenwich observers have shown to be 0·05″ in error, and should therefore have arrived at a perihelion date differing from theirs by about one month. That this is not so indicates that some serious error crept into his calculations, and it is suggested that, as the difference is so important from a gravitational point of view, the discordance should not be allowed to remain unproved. Mr. Merfield and Messrs. Crawford and Meyer appear to have deduced their value of μ from the recent observations alone, a procedure which Drs. Cowell and Crommelin deprecate as untrustworthy; and the value obtained by the Berkeley computers is enormously in error. According to the Greenwich calculators, the value for 1910 is $\mu=46{\cdot}6747''$, but this cannot yet be accepted as definitive.

A number of observations of the comet's brightness, made by Prof. Wendell, Mr. Leon Campbell, and Dr. Holetschek, are also published in the *Astronomische Nachrichten*, and the Harvard observations are plotted with the theoretical curve derived from the formula $1/r^2\Delta^2$; this shows very plainly the physical action produced by the solar rays as the comet got nearer the sun, the magnitudes increasing during this period beyond the rate demanded by the formula.

In No. 1, vol. xxxii., of the *Astrophysical Journal* Mr. Slocum describes the observations of the sun made at the Yerkes Observatory on May 18 and 19. Direct photographs and spectroheliograms are reproduced, and will serve as comparisons for any phenomena that may be attributed to cometary influence; nothing abnormal was noted.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. H. WREN, of Birkbeck College, has been appointed professor of pure and applied chemistry at the Municipal Technical Institute, Belfast.

MR. J. M. CAIE, organiser in Inverness and Ross for the North of Scotland College of Agriculture, has been temporarily appointed lecturer in agricultural education in the college in the place of Mr. R. B. Greig, who has gone to Australia as a member of the Agricultural Commission.

NEXT session will be the hundred and fifteenth of the Glasgow and West of Scotland Technical College. In 1886 the present college was formed by the amalgamation of several institutions, including Anderson's College, which dated from 1796. The new calendar provides abundant evidence of the flourishing condition of the various departments included in the college. The first section of the new buildings, consisting of five large wings, we notice, was opened in 1905. The second section was opened in 1908, and comprises the main entrance hall, additions to the library and mechanics' laboratories, class-rooms for the decorative trades, and laboratories for dyeing, bleaching, &c. The third section was opened in the following year, and contains additional accommodation for civil engineering, engineering drawing, and other subjects. The fourth section will, it is expected, be ready for the coming session, and within it provision will be made for the department of textile manufacture. The plan of confining each department to one floor has been followed in nearly every case, with the result that the internal arrangements are well adapted to promote efficiency in working. The whole building comprises over seven acres of floor space, and forms one of the largest structures in Great Britain devoted to education.

THE sixth annual report of the Education Committee of the County Council of the West Riding of Yorkshire deals, among other matters, with the part the committee has taken in providing university and technical education in the area for which it is responsible. The grants of 4500*l.* to the University of Leeds and 1500*l.* to the University of Sheffield have been continued. In addition to these sums, the University of Leeds has received 775*l.* to provide extension science lectures, instruction in coal mining, and free studentships for disposal by the County Council; and the University of Sheffield 500*l.* for Saturday mining courses and other purposes. So far as technical education is concerned, the greatest difficulties continue to be encountered in the rural portions of the Riding, where the meagreness of population and the prevailing conditions of life and work are less favourable to the successful maintenance of evening schools than in the more populous areas. In the mining districts the difficulty, which has always been a serious one, of maintaining regular attendance, has been accentuated during the session owing to the operation of the Eight Hours' Act rendering it almost impossible for students to change their shifts. The committee has the matter under consideration, and hopes to find a solution of the problem before the opening of the coming session. A satisfactory increase in the proportion of students attending for group courses of instruction is again reported. Practically all the West Riding schools are now organised on this basis, with the result that the educational equipment of the students is much more effective than when attendance for isolated subjects was the general rule.

THE issue of *Science* for August 19 last contains an article providing tables giving data in regard to the degrees of doctor of philosophy conferred by the universities of the United States. There were conferred this year 353 degrees, not quite so many as in the three preceding years, when the numbers were 366, 378, and 387. Almost exactly half the degrees conferred last year were in science. The universities, however, differ considerably in the relative importance of their work in science. Chicago appears to be the best balanced; it has conferred just half its degrees in the sciences and half in other subjects. At the Johns Hopkins and Cornell about 60 per cent. of the degrees are in the sciences, whereas the percentage is about 40 at Harvard, Yale, Columbia, and Pennsylvania. There is not a preponderance of the sciences in the State universities, the percentage of degrees at Wisconsin being only 37 and at Michigan 38. Boston University appears to have conferred only three scientific degrees out of seventy-four. There was this year a large fall in the number of degrees in science conferred by Columbia, eleven, as compared with twenty-one and twenty-three in the two preceding years. Cornell, on the other hand, conferred this year twenty-seven degrees in science, surpassing all the other universities. Interesting particulars as to the varying popularity of different subjects of science are given. Chemistry, with forty-eight degrees, leads, having about double the numbers in physics, zoology, psychology, and mathematics. Botany comes next, and there is then a considerable drop to geology, followed by physiology and astronomy. In the case of the subjects not ranked under the natural and exact sciences, most degrees have been given in English history, economics, and philosophy.

ON September 6 the *Times* published its first Educational Supplement, and if subsequent issues reach the same high standard of interest and usefulness, these supplements should do a great deal to educate the general public in educational matters and to develop an intelligent appreciation of the importance of securing for this country as efficient a system of national education as can be found anywhere. The articles, which are numerous, deal with many aspects of a complex problem; they are all, moreover, inspired by a broad outlook and a desire to assist the attainment of efficiency. Great prominence is given to the work of secondary schools and universities, and the importance of securing the right relationship between these grades of education is emphasised. One article, entitled "New Universities and New Schools," comes appropriately after the address of the principal of the University of London to the British Association last week. It deals with the difficult question of where the work of the secondary school should end and where that of the university should begin, and endeavours to make clear what precisely may be expected of a student desiring to matriculate. The writer properly maintains that it ought not to be impracticable to devise a leaving certificate in which both the views of schoolmasters and the university authorities are represented. The passport of entry to the university must certify both that the student is fit to leave school and that he has this or that range of abilities and equipment to enable him to undertake the work expected of him. The new venture deserves to succeed, and we commend this first issue to the attention of all who are interested in educational matters.

THE forthcoming opening of the winter session of work at the technical colleges throughout the country is, as usual, preceded by the publication of a large number of new calendars and prospectuses. Among these, that of the Municipal School of Technology, Manchester, takes a prominent place by reason of the completeness of its provision of instruction in every phase of technical education which is likely to appeal to students in south Lancashire. This calendar, which runs to some 520 pages, shows that the school is fulfilling thoroughly its object of providing instruction in training in the principles of science in their application to the industrial arts. We are glad to notice that the authorities here insist that it is impossible for a student to obtain full benefit from the courses of

instruction unless there has been adequate previous preparation, and that students are required to pass an entrance examination in subjects of general knowledge or to produce evidence satisfactory to the principal of their attainments. Special attention may be directed to the fact that the courses in the respective departments prepare for the degree of Bachelor or Master of Technical Science of the Victoria University of Manchester in the case of students who have matriculated, and that special courses of fourth-year post-graduate study and research are offered. The University of Liverpool publishes separately the particulars in connection with the faculty of engineering, of which Prof. J. A. F. Aspinall is chairman. The courses of study in the faculty afford a general scientific training for those who intend to become engineers, naval architects, architects and surveyors. The training is to be regarded as either preliminary to, or supplementary of, a pupilage under some engineer or course of apprenticeship with some engineering firm. Arrangements are made for students to spend the summer vacation in works, or to take a voyage as junior engineers in steamships. The prospectus of the evening classes and of the secondary school in connection with the East Ham Technical College points out that the numbers of students seeking admission have been so great that it has been found necessary to increase the accommodation by converting some of the workshops into class-rooms, and building a separate block of workshops and gymnasium at a cost of 3000*l*.

THE Aërial League of the British Empire proposes to found a practical school of aviation as a memorial to the late Hon. C. S. Rolls. In a circular letter recently received from the secretary of the league it is pointed out that such schools only exist abroad, and that few opportunities exist in England where students may attend laboratory classes; also that there are absolutely no facilities (except for very rich men) for practical tuition in the construction and handling of flying machines or for experimental testing of the selected designs of deserving inventors. A subcommittee of the league has been at work for some time past upon the project, and their proposals (which have been approved by the executive committee) are as follow:—(1) The primary aim of the school is to provide training in aëroplane manufacture and flight and to obtain a class of men grounded in the whole subject from beginning to end, the instruction to include such laboratory and theoretical work as funds and the gifts of apparatus may permit. The proposed laboratory to be situated centrally in London, to be open for the use of students from various technical institutions already providing elementary classes in the theory of flight, and also for public demonstrations in order to spread interest. (2) The school of aviation to be situated as near London as possible, and to be open to men who have undergone courses of training in great engineering schools, competent engineers, and mechanics. (3) The attention and the practical work of students to be chiefy directed to securing machines offering greater trustworthiness and stability, lower power and fuel consumption, diminished capital cost and expense of maintenance, and a higher factor of safety than the apparatus now used mostly in sporting contests. (4) In order that an early start may be made, two machines should be bought at once. Students themselves to build all further machines, and also those of selected inventors whose ideas are judged to be worthy of construction and practical trial. The result of this will be that novel machines can be built and tested at very low cost, and students, inventors, and instructors will alike benefit by the experience and analysis of results obtained. (5) Funds to be administered by an independent committee of management, including practical men of science and education experts. The estimated cost of the school is 1300*l*., and that of its running for the first year 1200*l*., *i.e.* 2500*l*. for the year, and the league solicits the generous and prompt support of all sympathisers.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 29.—M. Armand Gautier in the chair.—Joannes **Chatin**: The posterior sclerotic ring in birds.—M. **Gonnessiat**: Observation of the Arrest comet at the Observatory of Algiers. This comet was detected at Algiers on August 26, appearing as a feeble nebulosity with a slight central condensation of the fourteenth magnitude.—M. **Baillaud**: Remarks on the above. This comet has a period of six years eight months, and was not seen in 1904. Its position coincided with the calculations of M. Leveau, the difference between the calculated and observed positions being less than the ordinary field of a telescope.—Kotaro **Honda**: The law of variation of the coefficient of specific magnetisation of the elements by heating. Instead of the two laws of Curie, the author proposes the following: the effect of a rise of temperature on the magnetisation coefficient of an element is similar to that of a small increase of the atomic weight of the element. The experimental data in support of this are given.—G. D. **Hinrichs**: The atomic weights of precision of oxygen and silver.—M. **Busignies**: Some ethylenic cyclic derivatives (ether oxides) and their bromine derivatives. The alkyloxybenzophenones are treated with magnesium alkyl iodides, and give alkyloxydiphenylethylene and its homologues. The bromine addition compounds of these have also been prepared.—E. **Voisenet**: New researches on bitter wines and the acrylic fermentation of glycerol. Determinations of the amounts of acrolein in various wines showed that the bitterness increased with the amount of acrolein present.—Z. **Skrzynski**: Contribution to the study of mycosic serodiagnosis.

CONTENTS.