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THE STONE AGE IN NORTH AMERICA.

The Stone Age in North America: an Archaeological Encyclopaedia of the Implements, Ornaments, Weapons, Utensils, &c., of the Prehistoric Tribes of North America, with more than three hundred full-page plates and four hundred figures illustrating over four thousand different objects. By W. K. Moorehead. Vol. i., pp. xii+457; vol. ii., pp. vi+417. (London: Constable and Co., Ltd.; Boston and New York: Houghton Mifflin Co., 1911.) Price, 2 vols., *il.* 11*s.* 6*d.* net.

MR. MOOREHEAD has produced two handsome volumes amply illustrated. They deal with a subject that has scarcely ever been treated as a whole. Special aspects of the use of stone by the older inhabitants of the American continent have formed the subject of monographs by Wilson, Abbott, Holmes, and others, but no one has ever ventured to deal with the entire field. Mr. Moorehead is an enthusiast for his subject, a condition of mind that inevitably lends a human interest to his book, while, almost as surely, it leads him into sundry exaggerations. He takes up the position of the strongly convinced advocate rather than that of the impartial judge. This attitude is one by no means uncommon in books produced in the United States on subjects depending upon induction and hypothesis, rather than upon observed facts. Nor is the attitude unknown in Europe; but the conditions differ in an important manner. On this side the literature of our prehistoric periods is already fifty years old; certain facts and a definite terminology have been generally accepted; the main grouping is again an accepted fact, and the result is that, to write intelligibly, the author of a new treatise is compelled to subscribe to these conditions. The common terminology may be right or wrong; it may, and often does, beg the question, but the system is practical, inasmuch as it enables the writer to state his arguments and the reader to understand them, without pausing to disentangle the meaning of the terms in which they are stated. The book can thus be read without impatience, and it may be with profit.

Now one of the perplexing features of the productions of the Stone ages is the marvellous similarity in form of the implements from the most widely separated districts. This is, of course, a commonplace, for everyone knows that, *e.g.*, implements from South Africa, from the laterite beds of Madras, and, say, from Trenton, New Jersey, differ only in the material of which they are made. In the later neolithic times, such similarities are perhaps even more marked, and, in some ways, more astonishing, though, at the same time, each country has its characteristic forms.

This being the case, surely it would be wisdom, and tend to the elucidation of the problems of early man, if the writers of new treatises would endeavour to make their local discoveries fall into line with the scheme already accepted in Europe—if they would master and adopt the classification to be found in the text-books of the subject. It is not claimed for a moment that the scheme or the classification is perfect, or even that it is the last word, but only that it exists, and is generally adopted, while in addition, it is the considered judgment of a great number of men who have given their lives to the study. Mr. Moorehead and his committee, who five years ago undertook the classification on which his book is founded, do not appear to have given any thought to this aspect of the question, and have treated North America as archæologically independent of the rest of the ancient world. From one point of view they are certainly justified. In the United States the Stone age was in existence so recently that both the methods of manufacture and the purpose of many stone implements are matters of fact. Here the field is their own, and they need no external help, but in the main we have no hesitation in saying that conformity with European scholars would have been better.

While we have thought it desirable to formulate this objection to Mr. Moorehead's method, we can commend the matter of his book. It is called an encyclopædia, and the term is not inaccurate, for it comprehends practically all the types of later stone tools found in Northern America. Its intention is to supplement the very remarkable "Handbook of American Indians," published by the Smithsonian Institution in 1907. This work, reasonably enough, did not treat the Stone age as a special subject, and hence the complement now before us was produced. One cannot but regret that no place has been found in these volumes for a complete statement of the evidence as to the discoveries of Mr. Abbott at Trenton, New Jersey. Controversy raged fiercely at the time, and weighty opinions were to be found on both sides. A book with this title should certainly have dealt with the matter.

It may appear surprising to us that the discoveries in the mounds of America, of stone implements, pottery, and the like, are disclaimed by the existing Indians, though a comparison of the relics with those in use by the Indians until late years shows them to be very similar.

Such disclaimers are, however, common enough among primitive peoples. The negroes of West Africa will have nothing to say to the stone implements and images dug up in their plantations. It is probable enough that even if one or the other possessed either history or trustworthy tradition, they would equally disclaim any knowledge of the remains. In Africa the pressure of a superior civilisation from the East and North has produced a constant shifting of the tribes during, say, the last two thousand years. During the same period, or even less, economic and other causes must have created something like a nomadic condition in North America. For these reasons it might well be that the existing tribes on a particular spot would know nothing of the origin of the ancient burial places among which they lived.

One feature in connection with North American stone implements that is clearly brought out in Mr. Moorehead's illustrations is the astonishing likeness between some of them and others from Mexico. On p. 93 of vol. i. may be seen a group from Kentucky showing this similarity very strongly. The likeness

would not seem to be due to utilitarian causes, but rather to an artistic tradition. This is interesting in itself, but it also has a bearing on another point, perhaps even more interesting. On p. 162 of vol. i. is a curious group of chipped implements, some of them in the form of human profiles, while others are axes with curved sides expanding to a crescent-shaped cutting edge. It is well known that in passing from the use of stone to that of metal (often copper) the earliest metal axes are accurate copies of the stone type. Experience soon showed that hammering of the copper edge not only sharpened it, but, very naturally, widened it also, so that the natural result of the process was to produce a rounded cutting edge, with a curve from its two sides towards the butt. This resulting form, being at once more practical and more elegant, in turn became the type of copper or bronze axe.

These two facts, the presence of Mexican stone types, as well as types founded on a cast-metal prototype, in American Indian settlements, may well lead one to consider whether both one and the other had an origin further south than the United States. It may be contended that copper implements are common enough in the United States, and that there is no need to look further. But it is not of so much importance that the prototype should be of metal; it is that it should be of *cast* metal.

These are some of the many questions that are raised by the perusal of Mr. Moorehead's elaborate work. We can congratulate him on its encyclopædic character, a useful feature. The amount of material is amazing, and the exquisite implements from Tennessee in the Missouri Historical Society's museum will be a surprise to most people on this side. We could have wished that he had placed his figures somewhat nearer the text relating to them, and that his index had been a little better.

THE VULCANICITY OF OUR EARTH.

Die vulkanischen Erscheinungen der Erde. By Dr. K. Schneider. Pp. viii+272. (Berlin: Gebrüder Borntraeger, 1911.) Price 12 marks.

DR. SCHNEIDER opens his work by reference to what is found in many books on vulcanology and geology, namely, the part played by volcanic activities in the economy of nature. In consequence of volcanic action minerals of high specific gravity are brought to the surface, the contours between land and water may be changed, and new islands may be created. Since Tertiary times 3·96 mill. km.^{2} of land surfaces have been covered by volcanic ejecta. These accumulations have altered relative altitudes, on which climate, plant life, and other things depend. Valleys have been blocked, lakes formed, and river courses have been changed. At the time of an eruption a variety of gases and chemical products are brought to the surface, and many mineral deposits are closely associated with volcanic action. Although in many ways volcanoes have been beneficial to humanity, in their immediate vicinity they have been frequently associated with the loss of life and property. Volcanic explosions have excited the imagination, given rise to myths concerning subterranean deities or monsters, and indirectly have had an effect on literature and art.

At present we are told that on the surface of our world there is one active volcano to 1420475·5km.^{2}

We can regard volcanoes from a geographical, petrographical, chemical, and other points of view, and what has been done in each of these directions is briefly reviewed. The notes relating to the temperatures of lava and the average depth at which a rapid change might be expected in materials similar to those we meet with on the surface of our earth might easily have been extended.

Dr. Schneider's classification of volcanoes depends on their forms, and of these there are seven types. The names given to these types were quite as startling to me as was the word anhydrohepsepterion when I first heard it. It turned out to be a saucepan in which you can cook potatoes without water.

Pedioniten are fissure outflows like the Deccan Traps. *Aspiten* are characterised by the relationship of their height to an extended base, as, for example, Mauna-Loa. *Tholoiden* refer to forms with a gentle sloping base which runs inland from a coast and then suddenly rises with convex flanks to a rounded summit. *Beloniten* are illustrated by the needle-like peak of Mount Pelée. *Koniden*: these are mountains the flanks of which are convex-concave. A slight reference is made to this logarithmic curvature of volcanic profile which was first noticed in connection with Mount Fuji, but the lesson it teaches respecting the height of a mountain and the area of its base in relation to the material out of which it is formed, has apparently escaped notice. The relation of form to the size of ejectamenta, friction, wind, and the character of an eruption has not been overlooked. *Homaten.* In these the slope rises directly from the coast to the summit as in Hverfjell in Iceland. *Maare.* Here the volcanic neck has risen to the surface, clastic material has been spread widecast, and flat hollows have been created similiar to those in the crater lakes in the Eifel. Each of these types can also be found in the moon, and on our earth consists of materials with different physical structures. *Rheumatitische* material is that which flows like lava. The other materials may be clastic like lapilli and ash, gaseous and aqueous. Tertiary volcanoes are characterised by the prevalence of materials first referred to, whilst the materials of recent volcanoes are more clastic.

A chapter of considerable interest to geologists is one which gives an outline of vocanic action in Europe since Tertiary times. This, however, does not entirely overlook the vulcanicity which took place in earlier periods. The number of active volcanoes in the world during the Diluvium-alluvium period is estimated at 1081, whilst during historical times only 201 can be counted. These latter are grouped along great lines of dislocation in the larger features of the earth's crust. They do not occur in rows, but in relatively small zones. These are two out of eight laws formulated in connection with the geographical distribution of volcanoes, which is illustrated by numerous maps. The volume concludes with a catalogue of 367 volcanoes which have been active during

historical times. This number, it will be observed, does not correspond with the one just given. Although we observe certain lacunæ in this catalogue, it is a very useful compilation for those interested in vulcanology.

Although geologists may object to Dr. Schneider's new terminology, they must not overlook the fact that they themselves have had many christening parties. Some thirty or forty years ago a distinguished president of the Geological Society, when he first heard of Belenites—a word not unlike Beloniten—interrupted the speaker by the remark, "Tut! tut! Belemnites in volcanic rocks indeed!" If we say nothing about the new language, then Dr. Schneider is to be congratulated on his work. JOHN MILNE.

BIOMETRICAL METHODS FOR PSYCHOLOGISTS.

The Essentials of Mental Measurement. By Dr. Wm. Brown. Pp. vii+154. (Cambridge: University Press, 1911.) Price 3*s*. 6*d*. net.

THIS volume is based on a research "devised for the purpose of determining to what extent correlation exists between certain very simple mental abilities, in cases where the individuals experimented on are, as near as may be, identically situated with respect to previous practice, general training, and environment; and how closely, if at all, these elementary abilities are related to general intellectual ability as measured by teachers' judgments, school marks, &c."

The groups of individuals tested were homogeneous as far as possible, and were selected from a London elementary school, a London higher grade school, from among women students of a training college, and men and women university students. The tests employed were fourteen in number. In two of them the subject was required to cross out as quickly and accurately as possible on a printed page certain letters (e and r in one case, and a, n, o, s in the other), in a third all the letters were to be crossed out. Speed and accuracy in the addition of single digits were measured in a fourth; while in the fifth, sixth, and seventh the ability to estimate the relative lengths of printed lines was tested in different ways, including conditions under which illusions are known to be produced. The power of memorising poetry and strings of nonsense syllables were examined in the eighth and ninth, while the tenth test was the *combinations methode* of Ebbinghaus. In this "the subject is shown a passage of continuous prose with one-third to one-quarter of the words replaced by blanks, and is asked to supply the missing word or words of similar significance." The eleventh and twelfth were marks obtained in the ordinary school curriculum for drawing, and the total school marks; in the thirteenth general intelligence was graded by the independent estimates of two different teachers, which were found to be very closely correlated together. In the fourteenth association time was measured by counting the number of words associated with a given word which the subject could write down in a given time.

The majority, but not all the tests, were applied throughout each of the six groups, and the statistical treatment of the records is very complete and satisfactory. The results for each group were, of course, kept distinct, and correlation coefficients were calculated between the result of each test and the result of each of the others, while to estimate the trustworthiness of each the correlation between the results of two separate applications of the test on each subject was measured. In addition to this, certain groups of tests were taken and the partial correlation coefficients calculated, *i.e.* the correlation between any two members of a group for constant values of the remaining members. As the probable errors are given for all the coefficients calculated, comparisons between them can be satisfactorily made.

Limitations of space forbid us from giving an account of all the conclusions drawn by the author, but two at least can be stated very simply and are worthy of note; firstly, that the *combinations methode* of Ebbinghaus is a good measure of mental ability. It correlates with "general intelligence" almost as clearly as "scholastic intelligence" (school marks) "does"; and secondly, mechanical memory, *i.e.* the power of memorising a number of nonsense syllables, is also fairly closely correlated with general intelligence. This research was published in the British Journal of Psychology for October, 1910. Together with the chapters which appear in this volume on the mathematical theory of correlation and on the history of the use of the theory in psychology, it formed a thesis approved for the degree of doctor of science in the University of London. The thesis, with chapters added on mental measurement, psycho-physical methods, and on the significance of correlation in psychology, constitutes the bulk of the present volume. Its object appears to be not so much to instruct the beginner in psychology on the best way of measuring psychical characters, but to introduce the professed psychologist to the biometrical methods of Prof. Karl Pearson and his school. The author shows a considerable grasp of the subject, and does not perhaps realise the difficulties of less mathematically minded people than himself. Thus the chapter on the mathematical theory of correlation, if intended for an introduction to the subject, could well have been expanded, rendered more elementary, and more amply provided with examples. It is by examples rather than by precept that people who are confused by algebraical symbols are able to learn to use the methods. Those who can readily follow the notation will find the book profitable to read and useful for reference, particularly as a good bibliography is appended. E. H. J. S.

ELECTRIC CRANES.

Electric Crane Construction. By Claude W. Hill. Pp. xx+313. (London: C. Griffin and Co., Ltd., 1911.) Price 25*s*. net.

A LARGE measure of flexibility in the supply of power is an essential feature in all hoisting machinery. Not only must the point from which the load is suspended be capable of movement in different directions, but the whole machine must be able to travel, and these requirements render electricity a par-

ticularly well-adapted agent for the working of such machinery. A modern book on cranes becomes thus quite naturally a book on electric cranes.

Mr. Hill's work is a thoroughly practical treatise on electric crane construction. The subject is so complicated and so many-sided that any attempt to treat it in a general way must be unsatisfactory, and the author has wisely decided to represent his subject rather by means of well-chosen examples of successful work than by a general treatise. The importance of scientific principles is, however, not overlooked; interleaved with the descriptive matter we find the necessary calculations as to stresses, stability, power required, action of brakes, and other matters capable of scientific treatment. The examples chosen comprise various forms of overhead travelling cranes, locomotive and portable jib cranes, derricks, sheer legs, transporters, revolving cantilever cranes, and cableways. Then follows a chapter on the power required for crane driving. From tests quoted by the author, it appears that the efficiency in many cases is remarkably high, reaching nearly 70 per cent.

In discussing starting torque and acceleration, the author also quotes from practical experience for hoisting, lowering, travelling, and slewing. Chapter x. deals with the design of crane structures. Here we find discussed the strength of struts, both on the basis of Euler's and Rankine's formulæ, the strength of lattice girders and various types of beams generally, the construction of cantilevers and cognate matters, all exemplified by very full diagrams and working drawings.

The following three chapters deal with design of machinery, frames, bearings, axles, and drums, brakes and toothed gear. Especially the last-named subject is very fully treated, including the question of permissible wear and the use of worm-gearing. Most readers will be surprised at the high efficiency obtained by this mode of driving, when the worm runs in an oil bath. The explanation given by the author is that metallic contact between the teeth does not take place, since the film of oil between the surfaces is not squeezed out even at very heavy pressure. This has also been the experience of motor-car designers who find for worm-drive efficiencies well above 90 per cent.

After a short chapter on hooks, ropes, and chains, we come to the electric and magnetic details beginning with the design of magnets. It is to be regretted that the author has adopted the hybrid system of units where induction is given as so many c.g.s. lines per square inch. In working with such a system one loses completely the connection with first principles, and the solution of any problem becomes simply a matter of blindly applying certain formulæ. As regards motors, the author deals very fully with the question of rating as influenced by the intermittent service, and he shows that crane motors should, as regards mechanical strength and commutation, be designed for the full load, but as regards heating for a very much reduced load. Only D.C. motors are discussed, the author holding that A.C. motors are unsuitable for crane work. This is perhaps too sweeping a condemnation. In many docks on the Continent polyphase motors are used, and with the advent of the A.C. commutator motor there is given every facility for using alternating current where no continuous current is available, and the author's recommendation of installing a converter for the power supply to the cranes becomes a useless complication.

A table on p. 302, giving from practical experience the annual working cost of seven different cranes, is very interesting. It shows that the cost of power taken at 1·5*d.* per unit is negligibly small. It amounts in the worst case to only 1·3 per cent. of the total cost, and in most cases it is about 1 per cent. Thus, with current purchased even at the usual lighting rate of about 4*d.* per unit, the cost of power is quite insignificant. This is due to the fact that the load factor of a crane is exceedingly small. The total energy given off by all the crane motors per annum only represents full output over about twenty to seventy hours per annum. The annual cost is almost entirely made up by interest, depreciation, and repairs, and the problem to be solved by the designer of cranes is not so much the saving of current as the production of a cheap and robust design.

GISBERT KAPP.

MORPHOLOGY OF THE VERTEBRATES.

Éléments de Morphologie des Vertébrés. Anatomie et Embryologie Comparées, Paléontologie et Classification. By Prof. L. Vialleton. Pp. xiv+790. (Paris: Octave Doin et Fils, 1911.) Price 18 francs.

THIS is an interesting and thoughtful introduction to the morphology of the vertebrata, very clearly written, well illustrated, and with several distinctive features. The author thinks, probably with justice, that the vertebrata are better subjects than the invertebrates for the illustration of morphological principles. Their structure is more thoroughly known and its relations to the conditions of life are more certain; the development of the chief types has been worked out in its main features; and we have, on the whole, more information in regard to the past history. Filiation is clearer among vertebrata than among invertebrates. For learning the lessons of morphology it is better to begin with one phylum than with many, and the most educationally profitable phylum is that with which students are likely to be most familiar—the vertebrata.

The plan of the book is as follows. After an introduction dealing with general concepts such as homology, the author devotes the first part to general embryology—the germinal layers, the early primordia, and the fundamental architecture of head and trunk and limbs. The second part deals seriatim with all the systems and organs, from the skin to the gonads, treating everything comparatively and embryologically. It is all very clear and careful, but in a book of the dimensions of this one we look for rather more criticism. To take but a single instance, we think Vialleton's conventional account of the pectoral skeleton of the Monotreme, with its episternum and absence of procoracoids, might have been improved without risk of dogmatism. We may notice here that

there is a carefully selected bibliography at the end of each chapter, and that the references are punctiliously accurate.

The third part of the book gives a systematic account of the whole phylum of vertebrates, and takes due notice of the extinct forms. There are many interesting detailed expressions of the author's judgment, *e.g.* his treatment of the Ratitæ as a heterogeneous group derivable from at least three stocks, or his reuniting of Marsupials with Eutheria; but the outstanding feature in this section is to be found in the numerous carefully drawn up schemata showing distribution in time and probable affinities. There are twenty of these, condensing much reflection.

In the concluding section of his book, Prof. Vialleton deals analytically with the problem of the evolution of vertebrates. He discusses the origin of organs, and makes much of Kleinenberg's theory of substitution; he distinguishes between well-established genetic series and morphological series (so often mixed up together, *e.g.* in connection with the evolution of Equidæ); he recognises the importance of paying more attention to the phenomena of convergence; he gives an admirable discussion of correlation and of vestigial organs. Passing to the actual data bearing on the phylogeny of vertebrates, he marshals the palæontological facts in a masterly way, and discusses such points as the successive appearance of classes, the occurrence of generalised types and transitional types, the absence of the latter at phyletic bifurcations, the extinction of types, and the indubitable progress from age to age. Turning to embryological data we find an admirable critical discussion of the recapitulation doctrine, of which there is little left when the author has done. We cannot help feeling, however, that there is sure to be a rebound in a few years to some subtler rehabilitation of Haeckel's famous biogenetic law. The author believes in a good deal of polyphyletism, and he confesses himself a mutationist: *transformist* theories do not please him: "C'est l'évolution avec ses brusqueries et ses divergences qui constitue la réalité."

THE PRINCIPLE OF RELATIVITY.

Das Relativitätsprinzip. By Dr. M. Laue. Pp. x+208. (Braunschweig: F. Vieweg und Sohn, 1911.) Price 6.50 marks.

IT is almost impossible nowadays to glance through a journal containing original papers in physics without coming across something relating to the Principle of Relativity. This principle is an extension of that Newtonian relativity which enables us to treat machines on a moving earth as if they were at rest. The new extension covers the phenomena of optics, heat, and electromagnetism. It is sometimes called the electromagnetic principle of relativity, but as it contains also a mechanical principle it has now become usual to term it simply the Principle of Relativity. It asserts that physical phenomena generally do not depend upon rectilinear uniform translation through space; that, for instance, the optical isotropy of space is not affected by motion through it; that the velocity of light is the same in all directions and independent of displacement; and that it is therefore impossible to discover, say, the earth's motion of translation by any optical, electrical, or mechanical device. In fact, it is based upon the negative result of the Michelson-Morley experiment, and all other attempts to discover "æther-drift."

Einstein, who founded the modern relativity theory in 1905, based his arguments upon the impossibility of establishing an absolute time-scale, either as regards rate or as regards epoch, so long as the utmost limit of rapidity of signalling is imposed by the finite velocity of light. He showed how this limitation affects all measurements of length and time whenever the relative velocity dealt with approaches the velocity of light. The clocks in a moving system, synchronised by light signals, necessarily have a slower rate than those in a system at rest, in the ratio $\sqrt{1-\frac{v^2}{c^2}}:1$, where v is the relative velocity and c the velocity of light, and this applies whichever of two systems is regarded as being at rest. There is, in fact, no "absolute" time-scale.

Many conclusions from this principle appear far-fetched, even fantastic. Thus, not only electrons, but all matter possesses an infinite "mass" when moving with the velocity of light; mass is identical with latent energy; two particles projected in opposite directions with the velocity of light have a "relative" velocity which simply equals the velocity of light, and so on. In spite of such apparent absurdities, the Principle of Relativity has made what is no less than a triumphal march through the world's physical publications.

Dr. Laue's work comes, therefore, as a welcome contribution to what has become a matter of very living interest. He goes fully into the negative results of Michelson, Trouton, Brace, Rayleigh, and others, the positive results of Wilson, Rowland, Eichenwald, Lebedew, Poynting (misspelt "Pointing"), and Fizeau, and the theoretical work of Lorentz, Einstein, and Minkowski. He shows that there is no physical evidence against the principle, and that it has the advantage over other systems of accounting for the absence of æther-drift. In the analytical work, a vector algebra on the basis of Heaviside's notation is used, but it is made, after Minkowski's example, four-dimensional. A brief summary of operations with these "world-vectors" is of great assistance to the reader. E. E. F.

OUR BOOK SHELF.

The Principles of Electric Wave Telegraphy and Telephony. By Prof. J. A. Fleming, F.R.S. Second edition (revised and extended). Pp. xx+906. (London: Longmans, Green and Co., 1910.) Price 28*s.* net.

WHEN reviewing the first edition of Prof. Fleming's book five years ago we pointed out that it filled to perfection the want for a thorough and exhaustive treatise on the subject of wireless telegraphy, and was sure of a warm welcome on that account. Since then the volume has been twice reprinted, and now there is issued a new edition largely rewritten and considerably improved. The rapid pro-

gress in electric wave signalling is indicated even in the title, which is now so worded as to cover the subject of Hertzian telephony, at the time of the first edition so much in its infancy as not to be worthy of inclusion. To this subject Prof. Fleming now devotes a short final chapter, in which he reviews briefly the special difficulties in transmission and summarises the present position. (In the last paragraph, by an obvious oversight, telegraphy is written in place of telephony.)

Much of the volume has had to be revised on account of the progress which has been made in all directions. The author has acted wisely in curtailing the historical portions and devoting himself mainly to the explanation of the scientific principles on which the art of wireless telegraphy is based, and on which the numerous instruments now used are founded. The purely historical side of wireless telegraphy is now more or less a matter of the past: it has entered into a period of development which if less sensational is of more benefit to mankind. From the more or less crude empirical art of ten years ago wireless telegraphy is now firmly based on a solid scientific foundation, exact methods of measurement have been developed, and steady progress, not less rapid because of its steadiness, is possible. Prof. Fleming's book still deserves to rank as the best existing treatise on the subject, at any rate in the English language, and if the same industry is shown in the future in keeping it up to date it should continue for long to hold this premier position. M. S.

Die Anwendung der stereographischen Projektion bei kristallographischen Untersuchungen. By Prof. H. E. Boeke. Pp. viii+58+plate. (Berlin: Gebrüder Borntraeger, 1911.) Price 2.60 marks.

THE stereographic is the form of plane projection of the sphere ordinarily in use in crystallographic work, and during recent years it has come much into vogue, not merely for showing the zonal relations subsisting between the poles corresponding to the faces of a crystal, but also as a means of checking the accuracy of the calculations involved in the goniometric measurement of a crystal. Accordingly, various methods by means of nets or protractors have been devised to facilitate the use of the projection, many of which have scarcely yet found their way into the text-books. Penfield provided for English readers in a series of brilliant papers that appeared in *The American Journal of Science* a clear and concise account of the best and most practicable methods, and, moreover, designed various diagrams to aid the student in plotting the positions of the poles.

In the present volume Prof. Boeke aims at providing similar privileges for German readers. He gives a clear account of the properties of the projection, and discusses at some length its use as an aid in computation in the case of the several kinds of systems of crystalline symmetry, both geometrical and graphical proofs being given of the fundamental propositions. The application of the projection to crystal drawing and the determination of the optical characters are also explained. A pocket in the cover contains one of Prof. Wulff's stereographic nets, which are graduated in distance and azimuth referred to a pole in the equatorial zone for every other degree, the size of the sphere being the same as that selected by Penfield, viz. 14 cm.

The book is one that may be commended for the use of students of crystallography, but it might advantageously have included an adequate description of the properties and use of the gnomonic projection which at present is merely alluded to in a brief paragraph, even though some slight alteration of the title would have been involved.

Quaternions as the Result of Algebraic Operations. By Dr. A. L. Baker. Pp. ix+92. (London: Constable and Co., Ltd., 1911.) Price 6*s.* net.

IN this book the author establishes the principles of quaternions by the use of the six operations—addition, subtraction, multiplication, division, reversion, and mean reversion. By the introduction of reversion, we pass from arithmetic to algebra. Complex functions depend on the recognition of mean reversion, the operands still being scalars; and when the operands are scalars and vectors, the method becomes generalised into quaternions.

The key of the argument is the conception of *mean reversion*, that operation which twice repeated reverses the quantity operated on. There is nothing new in this, but Dr. Baker applies the conception in an unusual way to the representation of a scalar as a sphere in space, which, as possessing perfect symmetry and therefore devoid of direction in space, is the only available ideographic symbol for a scalar. He finds that a mean reversed scalar is represented in all its properties by a directed magnitude in space, that is, by a vector. The algebraic representation of mean reversal is, of course, $\sqrt{-1}$, leading to the usual Argand diagram; and the same idea enters into the constitution of any vector. The argument that $ii=-1$ may be accepted as sufficiently sound; but it may be doubted if the rule for the product of perpendicular vectors, viz. $ij=k$, &c., can be rigorously deduced on the assumption that the operation of a vector α upon a perpendicular vector β must be the same in kind, but as far removed in detail from that which would have been used had β been parallel to α. We certainly prefer Hamilton's own somewhat metaphysical argument.

It is clear that Dr. Baker has no regard for the views of those self-styled purists who deny that a vector can have versor properties. Having established the well-known i, j, k rules, he develops in a satisfactory manner the important properties of quaternions, and ends his discussion by a useful account of the linear vector function. Students new to the method will probably find the argument in the earlier chapters difficult to follow; thereafter all is plain sailing.

C. G. K.

Lessons on Soil. By Dr. E. J. Russell. Pp. xv+132. (Cambridge University Press, 1911.) Price 1*s.* 6*d.*

A COURSE of lessons on soil provides an essential sequence to the formation of school gardens if it is desired to make the best use of the latter. Teachers contemplating such a course are strongly recommended to consult this excellent primer, in which Dr. Russell presents a series of lessons evolved from practical classes conducted for children in the higher standards at an elementary school and in an intermediate form at a secondary school. The earlier chapters contain simple experiments for observing the properties of clay, sand, and other soil constituents; pot cultures are introduced to compare the food value of soil and subsoil, as also the action of water in soils; methods are described for detecting the presence of soil organisms and for demonstrating the advantages of hoeing. Finally, the practical bearing of the lessons, which it should be noted are confined to soil physics, is indicated, not only with reference to agriculture, but also as they serve to explain the aspects of the countryside and other natural features such as the connection between stream, ford, and village. The primer is not only practical and informative, but is designed to arouse the inquiring instinct. It is the first volume of a new series contemplated by the Syndics of the Cambridge University Press.

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 "Earthquake House" at Comrie.

I RECENTLY visited the "Earthquake House" at Comrie, and was sorry to find that, in the matter of repairs, it had been neglected for a long time, and was in a very dilapidated condition.

It may be remembered that this small building was erected in 1872, through the combined efforts of the British Association and Mr. Drummond, for the purpose of carrying on observations on the, then, frequent manifestations of seismic activity experienced in that district, and I believe the investigations made there, with the simple apparatus and methods employed, represent some of the earlier attempts to obtain definite data respecting the direction, duration, and intensity of seismic vibrations. From these and other early observations, I suppose, the modern science of experimental seismology has been evolved, and for this reason the building should always be regarded as of great scientific and historical interest, and its preservation a matter of common desire. Though the original wooden pins which were used have disappeared, some of the white sand that was placed on the floor some forty years ago is still to be seen there.

Mr. J. J. Macdonald, of the Commercial Bank, Comrie, has most kindly associated himself with me in an endeavour to obtain permission to place this property in the hands of a committee, and to raise funds for the purpose of protecting it and putting it in a proper state of repair. We propose to fence it in so that it may be preserved from the depredations of children and others (who now have free access to it) for all time.

Without now entering into the details of the trouble and correspondence our negotiations have entailed, I may say that the owner has kindly given us full permission to take such steps as may be necessary for the restoration and protection of the building, and that we hope to place it, as far as possible, in its original condition without delay.

An estimate has been submitted to us, and the sum required to carry out all the necessary work is about 30*l*.

May I ask those of your readers who are interested in this matter to subscribe towards this sum? Mr. Macdonald has kindly consented to act as treasurer, and all donations should be sent to him without delay. The names of those forming the committee, a list of subscribers, and the details of the work done, will be published later.

CECIL CARUS-WILSON.

Preston Vicarage, Faversham, September 11.

The Upper Trade-winds.

RECENTLY Herr Peppler[1] directed attention to the fact that the air-pressure gradient from the equator towards the subtropical zones, which is positive at the heights at which the anti-trade-winds blow, must be negative in still higher layers (±20 km.).

Owing to the low temperature of the stratosphere above the equator, the mean temperature of the whole air-column up to these heights is lower above the equator than above the subtropical zones, and Herr Peppler accordingly supposes that the air pressure at the top of the column is also lower.

Consequently, we may expect to meet above the anti-trade a wind blowing towards the equator, and it would be reasonable to call this wind the *upper trade-wind* (*Oberpassat*; *Vent alizé supérieur*). The ascents of registering and pilot balloons made during the last two years at Batavia Observatory have given some proof of the existence of this upper trade-wind.

Regarding the air-pressure gradient, I compared the pressures recorded during the balloon ascents made on the *Otario* cruises in the North Atlantic, in ±30° N. latitude, with those found at Batavia in the corresponding southerly season. These mean pressures and differences follow hereunder :—

Height	Air Pressure: Batavia 6° S	N. Atlantic ±30° N.	Difference
km.	mm.	mm.	mm.
12	164	157	7
13	139	136	3
14	119	117	2
15	100	99	1
16	86	85	1
17	74	74	0
18	63	65	−2

Though the records are few in number, the decrease and reversal of the gradient are conspicuous.

The numerous balloon-flight observations now made in Batavia (the results of which are just going to the press) have proved that the anti-trade reaches a maximum at a height of 12–15 km. (in the dry season lowest and in the rainy season highest). Higher up its strength decreases, and at heights of ±17 km. feeble southerly and westerly winds blow. Berson was the first to observe these winds in Central Africa.

The height at which I found them above Batavia, viz. ±17 km., corresponds exactly with that in which the pressure gradient passes the zero value.

Still higher up we must expect to meet the upper trade, and the explanation of the occurrence of these southerly and westerly winds simply is that they are feeble winds of variable direction occurring between two great overlying air currents, similar to those which are often observed in the layers between trade and anti-trade, or monsoon and trade.

Recently the ascent of a balloon of 2 kg.,[1] which reached 22 km., gave fair evidence of the existence of the upper trade, as may be seen from the wind directions and velocities given hereunder :—

	Height	Wind blowing from	Velocity in m. p. sec.		Height	Wind blowing from	Velocity in m. p. sec.
	km.				km.		
Anti-Trade	13	E 15 N	12·8	Upper Trade	17·5	E 85 S	4·6
	13·5	E 22 N	15·2		18	E 25 S	8·8
	14	E 32 N	15·2		18·5	E 7 S	13·6
	14·5	E 35 N	20·8		19	E 9 S	15·0
	15	E 34 N	21·2		19·5	E 4 S	21·1
	15·5	E 23 N	28·8		20	E 11 N	28·5
	16	E 4 N	24·0		20·5	E 3 S	27·2
	16·5	E 16 N	26·9		21	E	27·2
	17	E 15 N	7·5		21·5	E 9 S	30·4
					22	E 10 S	30·8

The present dry season is not advantageous for the discrimination of the upper trade from the upper easterly counter-wind, because, according to the difference observed between the dry and wet season, in this season pressure at those heights is lowest probably over Java and not over the equator. Consequently, the southerly components by which the upper trade differs from this counter-wind will be small.

In the rainy season (December-February), however, the contrary will be the case, and accordingly I expect to obtain in those months observations which will give stronger evidence of the existence of the upper trade-winds.

W. VAN BEMMELEN.

Batavia Observatory, August 20.

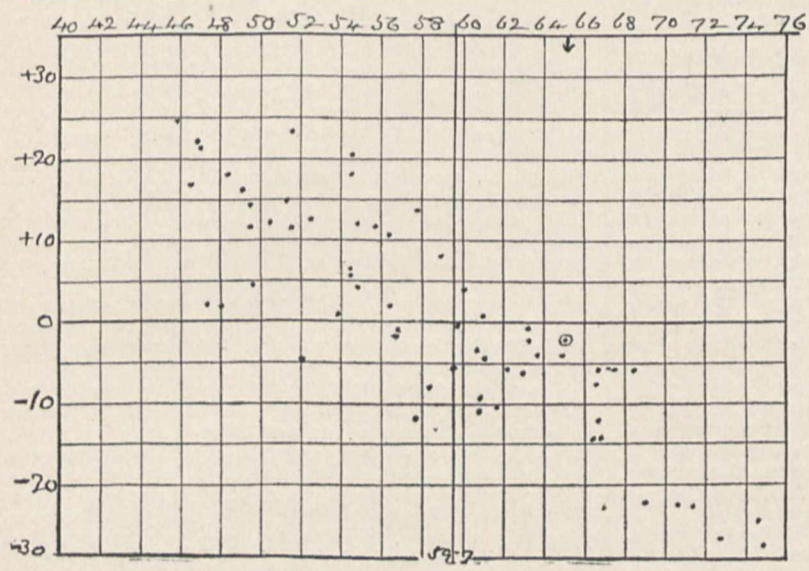
Rainfall in the Summer of 1911.

ONE does not hear much of effort on the part of official meteorologists to supply long-range forecasts of months, seasons, &c. It may be said, the thing cannot be done; better to say, it cannot be done infallibly. My own experience leads me to think a beginning might now be made with what will no doubt some day be a familiar institution, like the useful but imperfect daily forecast.

[1] Beiträge zur Physik der freien Atmosphäre. Bd. iv., Heft 1.

[1] This balloon reached as a registering balloon a height of 15·5 km. on July 18; at that height it burst, was found again and brought back, and after being carefully pasted, it was sent up again on August 3 as a pilot balloon, being observed from two points 1·9 km. apart.

The question may be asked, Could the remarkable qualities of this summer (so hot and dry) be foreseen in any measure? I consider there was reason to expect a very small rainfall (at Greenwich); and I would submit the enclosed rough dot diagram in support of this view.



Rainfall comparison of Greenwich summer.

It is got thus: the rainfall of spring plus summer (March–August) in each year, 1841–1910, is noted, and these values are added in groups of five (1841–5, 1842–6, &c.). Then each sum is compared, by the dot method, with the difference between it and the *fifth* after, a plus value meaning that the later sum is the higher, while a minus value means it is lower. (Each dot signifies one sum by the horizontal scale, and the difference by the vertical.)

Before this summer we had got to comparing the sum for 1903 (*i.e.* the group 1901 to 1905), which is 68·4 inches, with the difference between it and the sum for 1908 (*i.e.* 1906–10), which is 6 inches (68·4–62·4). Next we have the sum for 1904, which is 65·3 inches, and the value for 1909 has to be ascertained (*i.e.* the group 1907–11).

Find 65·3 in the horizontal scale (see arrowhead), and consider where the new dot is likely to go. (The encircled dot shows its actual position.) It will be seen that, wherever the sums have exceeded (say) 62 inches, the fifth sum after has been a lower value hitherto. Let us lessen the sum 65·3 by 1 inch, and see what we get. We have thus 64·3 inches as (say) an extreme upper limit for the group 1907–11. Now, the sum for 1907–10 was known, viz. 54·5; and 64·3 − 54·5 = 9·8 for March–August, 1911. The spring had 5·2 inches, so that we might look for a summer rainfall not over 4·6 inches. (The average is 6·7 inches.) The actual amount appears to have been 3·7 inches. The difference of the sums for 1904 and 1909 is −1·9 inches; and the previous distribution of dots, indeed, points to a greater diminution than 1 inch.

ALEX. B. MACDOWALL.

Limits of Explosibility in Gaseous Mixtures.

IN making experiments recently on the explosion of gases by means of an incandescent wire, I have obtained much wider limits of explosibility than those usually given. The following table shows the numbers obtained:—

	Limits with incandescent platinum wire Per cent.	Limits (Clowes) Per cent.
Marsh gas	2·5 to 24	5 to 13
Coal gas	4 to 28	6 to 29
Hydrogen	3 to 75	5 to 72

In each case the gas was mixed with air. The explosion was carried out in a glass tube of about 10 c.c. capacity having a stop-cock at each end, and a mercury gauge of small bore attached to the middle of the tube. When the explosion occurs the mercury moves more or less sharply, according to the force of the explosion, but a distinct movement, apart from that due merely to the expansion caused by the heating of the wire, can be seen with the proportions of gases given above. The marsh gas was prepared from zinc methyl, as aluminium carbide, on treating with water, was found to give 33 per cent. hydrogen.

I am not clear as to why the limits should be wider than those usually obtained; possibly it is due to catalytic action of the platinum wire, or possibly the apparatus is more sensitive than that usually employed. The matter seems of interest in connection with colliery explosions. Using the same apparatus, I have obtained explosions with coal-dust and air, and with lycopodium powder and air, no other gas being present.

E. P. PERMAN.

University College, Cardiff.

Working Hypotheses *v.* Collection of Bare Facts.

PERHAPS it is desirable to explain that my review of Prof. Schuster's book published in NATURE of September 21 was written and sent to you before Prof. H. H. Turner had delivered his address to the British Association as president of Section A. Consequently, nothing in my review is a reply to, or has any reference to, Prof. Turner's excellent address. It would be discourteous to criticise an important pronouncement of a leader in science in any back-handed way. My statement and his are probably not really in opposition, though they to some extent emphasise opposite types of investigating activity.

OLIVER LODGE.

Use of Wind-furnaces in Smelting.

IT may interest your correspondent, Mr. George Turner (p. 381), to be reminded that wind-furnaces (furnaces without any blast but that of the wind) were used, at all events for lead smelting, much less than 900 years ago. Until some time in the seventeenth century the Derbyshire lead-smelters did not employ an artificial blast. They, like their predecessors in Roman times, built their furnaces on the tops of hills and facing the quarter of the prevalent winds. Dr. Percy in his "Metallurgy of Lead" gives extracts from Bishop Watson's "Chemical Essays" and from an earlier writer, Joshua Childrey, describing such wind-furnaces.

H. T. WOOD.

Royal Society of Arts, W.C., September 24.

Meteor-showers.

BESIDES the ordinary display of Orionids that occurs near the middle of October, a considerable amount of meteoric activity may be looked for about the beginning of the month. Indeed, the intensity of the earlier meteor-showers promises to be considerably greater than that of any of the subsequent ones in October. The following are computed particulars of two important meteor-showers that become due before October 6.

Epoch September 29, 3h. (G.M.T.), second order of magnitude. Principal maximum September 30, 18h. 25m. Secondary maxima September 29, 16h., and October 2, 16h. 25m.

Epoch October 5, 6h. 30m., third order of magnitude. Principal maximum October 3, 22h. 10m. Secondary maxima October 2, 2h. 45m., and October 4, 11h.

After these there will be meteoric quiescence until October 12.

JOHN R. HENRY.

2 Belgrave Villas, Rathmines, Dublin, September 26.

Habits of Dogs.

IN reply to Dr. Kidd's question as to the disposition of dogs to carry hedgehogs in their mouths, I may say that a smooth-haired Irish terrier, "Tim," of which I had charge for some weeks in the early spring of the present year, speedily became an expert hunter of hedgehogs, and carried home five living ones in the course of a month. I am inclined to think that he came upon the first one in its winter quarters quite by chance; but on almost every subsequent occasion, when taken out for a run after dark, he quickly disappeared amongst the gorse and ling, and, eluding my daughters, returned home alone with a hedgehog in his mouth. On one occasion he had cunningly bitten off the ends of a number of the spines on the back of his captive, and on only one occasion did I see blood upon his lips. H. C. CHADWICK.

The Biological Station, Port Erin, Isle of Man,
September 16.

WITH reference to the letter of Mr. Venables in NATURE of September 21, it may interest your correspondent to know that the stimulation from formic acid taken by the mouth *is* "out of proportion to the effect which one would expect from the mere acidity."

Formic acid is given in medicine for states of debility, *e.g.* following influenza, and a tincture made from the whole ant (*Formica rufa*) is given in homœopathy for certain nervous and rheumatic states.

H. FERGIE WOODS.

"Appledore," Park Drive, Golders Hill, N.W.,
September 25.

THE TURIN MEETING OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION.

THE fourth meeting of the International Electrotechnical Commission was held at Turin, and came to a close on September 16. For several reasons this meeting has established an international interest, not only for electrical engineers, but for mathematicians, engineers, and all interested in the standardisation of symbols used in mathematical literature and formulæ.

The opening business of the meeting consisted in the election of a new president; Dr. Budde, until recently the head of Messrs. Siemens and Halske, of Berlin, and probably the best known of the electrical engineers of Germany, was unanimously elected to fill the position in place of the retiring president, the eminent American physicist, Prof. Elihu Thomson. Colonel Crompton was re-elected as honorary secretary on the proposal of Prof. Feldmann, of Holland, who, in putting forward his proposal, referred to the St. Louis Congress of 1904, and the part Colonel Crompton took in urging the advisability of international cooperation in matters electrical. He said that Colonel Crompton was, in fact, the father of the International Electrotechnical Commission.

It was extremely satisfactory to note that Dr. Budde's election was proposed by the French delegates, which shows that at any rate any political differences which may exist between France and Germany do not extend to the more serene atmosphere of the scientific world.

The proceedings were formally opened by the reading of a report by the honorary secretary, Colonel Crompton, on the progress of the work since the last formal meeting, and more particularly since the informal meeting which took place at Brussels last year. He pointed out that whereas in 1908 there were only ten countries taking part in the Commission there were now twenty-one countries subscribing, each of which had formed its own local electrotechnical committee, in most cases with the direct aid of their respective Governments, and he thought it practically certain that at least three or four other countries were on the way to join, so that the movement might be called practically universal.

Prof. Elihu Thomson then gave an address as retiring president, and described the work carried out at the Brussels informal conference, and advocated that the work of the central office in London would be much lightened by the formation of a few international subcommittees additional to the one which already existed. He pointed out that the subject which required such continuous treatment by an international subcommittee was that of the standardisation of nomenclature and symbols used by mathematicians, engineers, and others, dealing with electrical questions, and he thought that the same might apply to the question of illumination as it was most desirable that the engineers engaged in illumination, not only by electricity, but by other means, should also standardise the expressions and formulæ they use. He emphasised the need of conducting the work of the Commission so that it may be a material assistance to the electrical industry, and so as not to retard progress or design in any way.

Two days were occupied by unofficial meetings dealing with the business in hand. A report on nomenclature was presented by Dr. Budde, the newly elected president, and after considerable discussion the amended list of terms and definitions drawn up in the two official languages of the Commission—English and French—was provisionally adopted. This list had been prepared by a subcommittee at a conference held at Cologne last May, and was thoroughly discussed and finally adopted at this meeting.

The next and very important matter was that of mathematical symbols. Here again the proposals put forward at the unofficial congress held at Brussels in 1910 were discussed, somewhat modified, and provisionally adopted; and a resolution was proposed by Dr. Budde, and seconded by Mr. Alexander Siemens, the president of the Institution of Civil Engineers of London, that the letters "I," "E," and "R" should be adopted to represent current, electromotive force, and resistance respectively in the simple algebraic expression of Ohm's law. It will be seen that in coming to this decision concessions were made by Germany dropping the letter "W" for resistance, and by Great Britain discontinuing the letter "C" for current. It is evident that this agreement on the symbols employed in Ohm's law will be a great convenience to all electrical students.

The discussion on symbols was a very thorough one, and the difficulties that appear likely to arise, at any rate amongst electrical engineers, are comparatively small compared with the difficulties of selecting suitable signs on account of the limited range of the type letters suitable for the purpose. For magnetic quantities either Gothic, Script, heavy-faced, or any special type was decided upon.

Although the matter was not in any way discussed at the conference, it appears likely that this difficulty could best be met by the substitution of a number of new symbols not necessarily representing letters of any type, but of a form and shape that they could be easily remembered and recognised, and which would be free from the present existing difficulty of causing great trouble to the composer in setting up his type and spacing his lines.

Eventually a subcommittee, consisting of one member each from Belgium, France, Germany, Great Britain, Holland, Spain, Switzerland, and the United States was appointed to continue the study of these international symbols.

The next interesting point dealt with was the vector diagrams in use for alternating-current quantities. It

was agreed that in the graphical representation of alternating magnetic quantities advance in phase should always be represented in the counter-clockwise direction; in other words, the rotation of the vector should be to the left.

On the question of rating of electrical machinery and apparatus the proposals of the Brussels conference were adopted without modification as follows:—

1. The output of electrical generators is defined as the electrical power at the terminals.

2. The output of electrical motors is defined as the mechanical power at the shafts.

3. Both the mechanical and the electrical power are to be expressed in international watts.

In this work careful attention had to be given to the exact choice of the equivalent words in the two official languages. The convenient word "output" employed by English-speaking nations has no exact equivalent in French. In this case again a sub-committee, consisting of one member from those international committees interested in the subject was appointed to carry on further this question of the international rating of electrical machinery and apparatus.

It was decided that the next meeting of the Commission should be held in Berlin in 1913, the exact date to be announced later.

Mr. Gano Dunn, the president of the American Institution of Electrical Engineers, invited the Commission to hold an official meeting at San Francisco in 1915, on the occasion of the opening of the Panama Pacific Exhibition. On the motion of Prof. Feldmann, of Holland, seconded by Mr. W. Duddell, of England, the meeting thanked Mr. Dunn for the invitation, and stated its willingness to hold a meeting in San Francisco in 1915, and instructed the Central London Office to cooperate with the American Society in the organisation of an international electrical congress to be held at the same time.

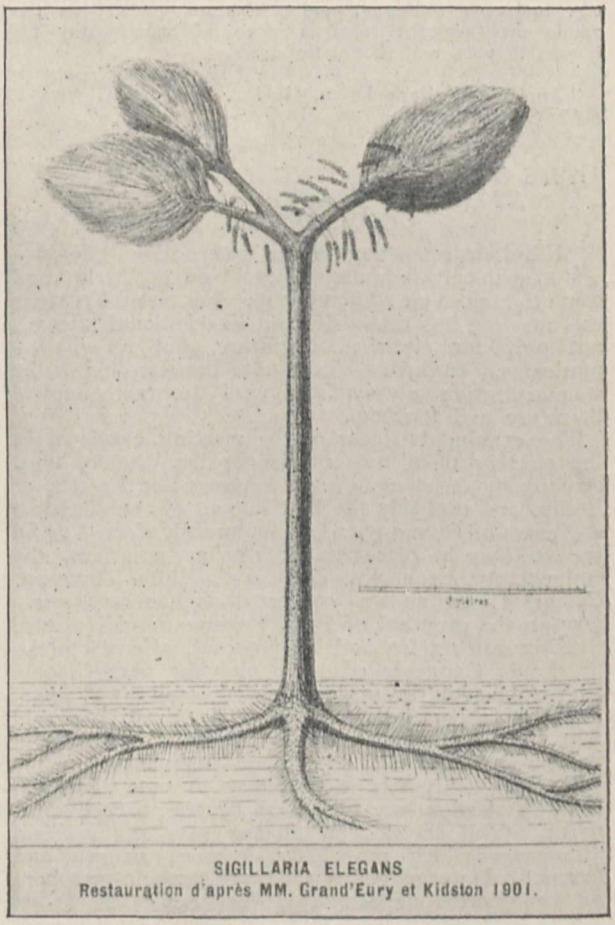
It is interesting to remark that at the meetings of the Electrical Congress, which was sitting at the same time, it was decided that for the future the irregular method of summoning international congresses at the time of the international exhibitions should be discontinued, and that in all cases where such exhibitions were held the International Electrotechnical Commission should be the body which should be invited by the country holding the exhibition to organise the electrical congresses, and in this way avoid much clashing and waste of effort.

Finally, the honorary secretary of the Illuminating Engineering Society of London, Mr. Leon Gaster, who was personally invited to attend this meeting at the invitation of the president, referred at some length to the desirability of standardising the terms and expressions used in connection with illumination. As stated above, this matter was dealt with by Prof. Elihu Thomson in his address. Mr. Gaster gave very cogent reasons why the present loose methods of expressing standards of light and of measuring these same standards should be discontinued, and that it was just as desirable in this kindred science of illumination that all nations should understand one another, as in the case of the electrical art and industry. Mr. Gaster's suggestions were strongly supported by Dr. Kennelly and Dr. Clayton Sharp, who are president and past president respectively of the Illuminating Society of the United States, and the suggestion that the various national committees be requested to put themselves in communication with their respective illuminating societies was unanimously adopted.

There is no doubt that at this full meeting of the International Electrotechnical Commission during the week in which the delegates worked together much international courtesy was shown, a great many pleasant friendships were made, and undoubtedly every additional international meeting of the kind greatly helps on the cause of solidarity between men of science of the world. The meeting room certainly contained a collection of men second to none in the electrical world for intellectual capacity; and that the meeting passed off so smoothly and so much work was done in a comparatively short time showed that the selectors of the delegates had also considered their diplomatic qualities, which had also been carefully studied by the countries which had sent them to the meeting.

PLANTS OF COAL-MEASURES.[1]

THE fossil flora of the Upper Carboniferous rocks of Belgian Hainaut is in many respects similar to that of our British coal measures, though many species occur in Belgium which are unrecorded from Britain and *vice versa*. Those who are interested in the systematic study of British Carboniferous plants



SIGILLARIA ELEGANS
Restauration d'après MM. Grand'Eury et Kidston 1901.

will therefore find much that is of interest in Dr. Kidston's description of the collections, preserved in the Brussels Museum, from this coalfield. In all, 191 species, included in more than fifty genera, are enumerated. It is scarcely necessary to add that the author's high reputation for the accuracy of his deter-

[1] Extrait des Mémoires du Musée royal d'Histoire naturelle de Belgique. Tome iv, "Les Végétaux Houillers recueillis dans le Hainaut Belge et se trouvant dans les Collections du Musée royal d'Histoire naturelle à Bruxelles." By Dr. R. Kidston, F.R.S. Année 1909. Pp. iv+282+xxiv plates. (Bruxelles: Polleunis et Centerick, 1911.)

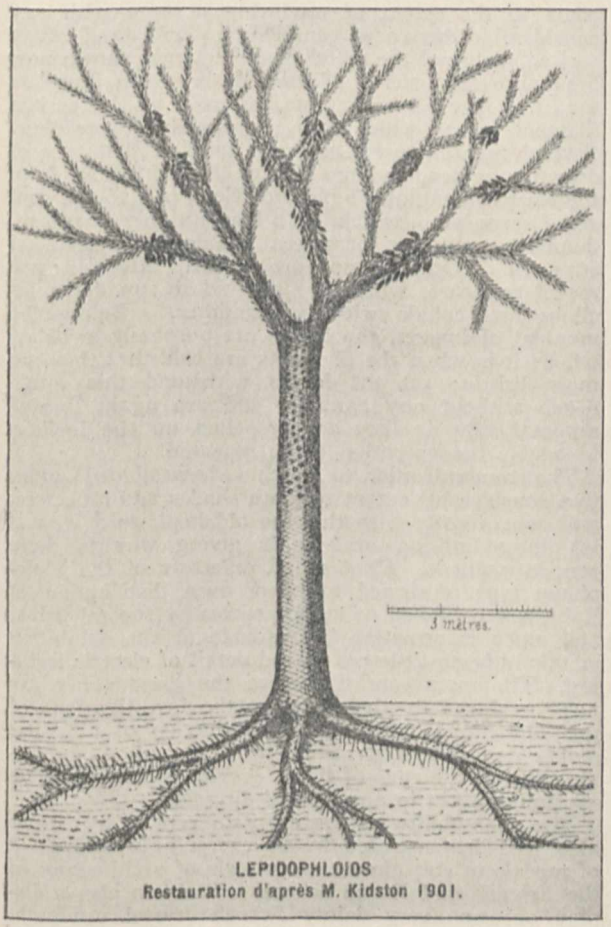
minations and the completeness of his tables of synonymy is fully maintained in this large memoir.

The work is in the main an enumeration of the species represented in the collection, with lists of synonyms. In the case of many of the rarer or more difficult species, the author has added notes of a critical nature which are often of great value. We may, however, regret that he has not seen his way to give a description of each genus and species involved. Such diagnoses would have added very greatly to the value of the work. As it stands it resembles the shell of a nut without the kernel, and in practice one will require to make use of another work containing such descriptions, in conjunction with that now under discussion, whereas one volume might have sufficed. We do not overlook the fact that in the case of a considerable number of genera, including Renaultia, Sphenophyllum, and Asolanus among others, as well as certain species of Sphenopteris, Sigillaria, and the like, none of which are new to science, a full diagnosis has been included. But in the majority of cases the author has apparently thought any description unnecessary, even where no figure of the plant is given.

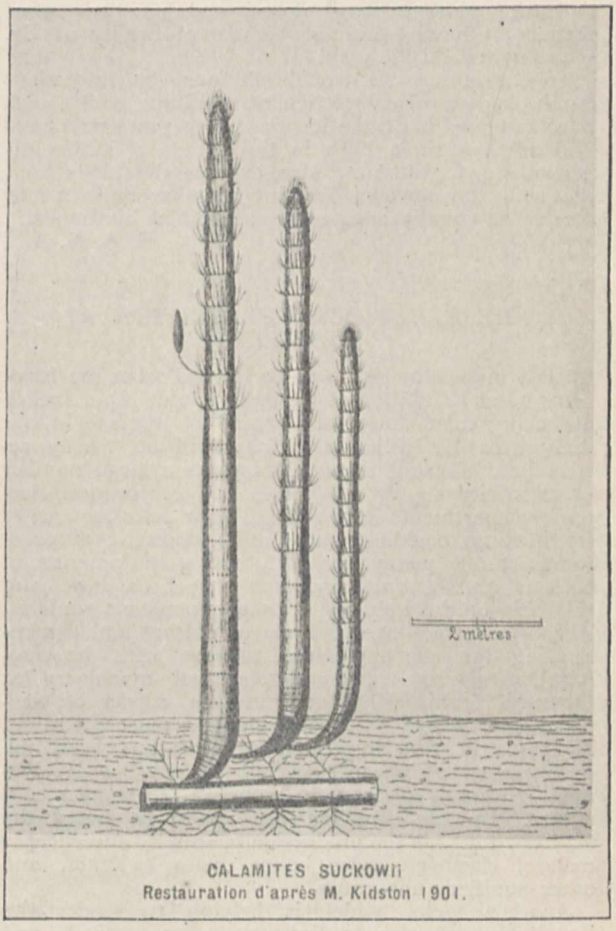
The number of new genera and species discussed is remarkably small. We notice only one new genus, Boweria, and two new species, both of Lepidodendron and Sigillaria. These with a couple of new seeds complete the list of new plants. The new genus is proposed for the reception of a widely distributed plant formerly known as *Renaultia schatzlarensis*, since its sporangia now prove to be annulate, and the genus Renaultia is reserved for certain plants with exannulate sporangia. Turning to the new Lycopods, *Lepidodendron simile*, of which, however, no diagnosis is given, appears to approach *L. lycopodioides*, Sternb.; and *L. belgicum* sp. nov., a stem in the Ulodendroid condition, which is fully described, has also some points of resemblance to Sternberg's species. The two new Sigillarias are both members of the straight-ribbed section with distant leaf scars, and of the type of *S. laevigata*, Brongn.

These and many other fossils are illustrated by twenty-four large plates from excellent photographs, reproduced with exceptional clearness. In the text there are forty-one smaller illustrations, all of a high average. Among these are twelve careful restorations from the author's own pencil of some of the most characteristic types of Carboniferous vegetation, such as *Sigillaria elegans*, a Lepidophloios, and *Calamites suckowi*, which are here reproduced. These embody the results of the author's lifelong practical experience of Carboniferous plants, and they are also interesting from the fact that in some cases they differ very remarkably from the restorations which are now to be found in most of our text-books. Without expressing any opinion on the accuracy of Dr. Kidston's drawings, we must, however, add that if these are faithful portraits of the plants of the period in question, the Carboniferous vegetation must have been even more weird in aspect than we had imagined.

Turning next to some further points of interest, we notice that the author, after many years' consistent use of the term Calamocladus for one particular type of Calamite foliage, has now apparently abandoned it



LEPIDOPHLOIOS
Restauration d'après M. Kidston 1901.



CALAMITES SUCKOWII
Restauration d'après M. Kidston 1901.

for the alternative Asterophyllites, which usually commends itself to Continental workers. The point may appear to be a small one, but any change of importance as regards nomenclature at the hands of the leading authority on the systematic study of Carboniferous plants in this country is worthy of note. Among the plants more fully described, on which new contributions to our knowledge are offered, we would particularly direct attention to the stems and cones of *Calamites paleaceus*, Stur., *Selaginellites Gutbieri* (Gœpp.), *Pinakodendron ohmanni*, Weiss, and *Sphenophyllum majus* (Bronn). The memoir concludes with a discussion on the age and horizon of the Hainaut basin.

In conclusion, the Belgian palæobotanists may be congratulated on this noteworthy addition to the literature on their fossil floras, and on their good fortune in having secured such an authority as Dr. Kidston to fulfil the task.

To the author we would add our congratulations on the successful completion of a volume which must have occupied his attention for many years past, and will always rank high in the annals of systematic palæobotany. We may also express the pious hope that some day our own British Carboniferous flora may receive an equally adequate treatment at his hands.

E. A. N. A.

THE ELECTRICAL EXHIBITION AT OLYMPIA.

THE important lesson to be learned from the Electrical Exhibition at Olympia is that rapid strides are being made towards a period of hygiene in our daily lives for which electricity will be wholly responsible. During the last six years a large number of electricity supply companies and corporation electricity departments have reduced their price for energy for heating, cooking, and similar domestic purposes to about one penny per unit, and manufacturers of cooking and heating apparatus have been developing this side of the industry with commendable rapidity. The large percentage of firms exhibiting and demonstrating domestic appliances, together with the comparative absence of heavy electrical machinery at Olympia, sufficiently indicates the aspect of electrical supply which is receiving the most attention. A factor in this important problem has been the development of cheaper wiring systems, a development purposely directed to securing the smaller consumer. In this direction also is to be noted the tendency towards the production of smaller and cheaper meters, cheaper service boxes, main switches, and other auxiliary apparatus.

Another factor which is helping to render the installation of electric light more economical, and therefore further within the reach of the smaller user, is that, owing to small devices, such as lamp-holders, switches and fuses being manufactured in large quantities, and practically to a few standard designs, the cost of these is now far less than it was a few years ago. This brings us to mention what is perhaps the most remarkable sign of the development of the electrical industry to the ordinary thoughtful observer outside the industry itself. Fifty years ago, or even less, electricity, except in so far as its applications to telegraphy were concerned, was practically an abstract science, fascinating no doubt on account of its potential developments, but scarcely a serious factor in engineering. Now, however, not only is electricity a most important agent in practically all branches of engineering, but the manufacture of electrical plant and apparatus has assumed the proportions of a great industry. It is the commercial aspect of this industry which is so very clearly brought home to the visitor at the exhibition, especially in the case of those smaller pieces of electrical apparatus which form the bulk of the exhibits. The manufacture and sale of these has developed into an enormous trade, and one can see that the exhibitors at Olympia are not only engineers and electricians, but are business men and traders, in the widest acceptance of these terms.

To return to the actual exhibits. It will be noticed that one of the most outstanding features of the exhibition is the improvement in electric lamps. Only a few years ago the metal filament lamp was an object of scientific interest, the difficulties of even squirting the filament not then having been overcome to the extent of producing a lamp with any considerable degree of capability to withstand rough usage. Some of the metal filament lamps shown now are exhibited under conditions designed to illustrate that they are as strong mechanically as the carbon filament lamps which they are rapidly superseding. Several manufacturers are now making filaments of drawn tungsten, and the *clou* of the exhibition, from the electrical engineer's point of view, is a 16-c.p. 220-volt Osram lamp, which has a filament only 0·015 mm. diameter, and yet possesses wonderful mechanical strength. Other lamps are shown, fitted on two model tramcars, which are allowed to run down inclines and collide with one another. Before the moment of impact, the lamps are purposely switched off, as it is when the filaments are cold that they are more brittle; yet the lamps withstand this rough usage without any damage, and are again lighted automatically as they are propelled up the inclines to enable the operation to be repeated.

The standardisation to which we have alluded applies to a considerable extent to lamp shades and reflectors, and concurrently with this the old haphazard way of installing lighting systems is giving way to more precise methods. Shades and reflectors of the Holophane type, designed to effect even distribution of light, are exhibited as stock articles by several firms, and much information is available at the exhibition in this hitherto little considered detail of electric lighting. The most careful arts of the glassworker are now employed to give effect to the investigations of the student of optics in the production of diffusing globes and reflectors which, by conservation and redirection of the rays of light, prevent waste and give maximum effect in any desired direction.

The adaptability of electricity to artistic fittings is also well demonstrated in an exceedingly fine show of models to suit almost every style of architecture of the English and Dutch schools. There is also a display of some very dainty French crystal pendants, together with reproductions of the genuine old Dutch lighting fittings of the sixteenth and seventeenth centuries.

A new development that may be mentioned is in connection with the mercury-vapour lamp. A "light transforming reflector" is being introduced, made of a material which becomes fluorescent under the action of the light from the lamp, and increases the number of red rays; although this has not actually solved the problem of converting the light from the mercury-vapour lamp into a pure white light, it is at any rate a step in the desired direction.

The visitor who proposes only to spend a short time at the exhibition in which to form an idea of the numerous domestic applications of electricity to which we have alluded will find a large number of these concentrated in the "Electric Home." This is a

suite of rooms consisting of drawing, dining, bed, and bath rooms, together with a kitchen and scullery, efficiently and beautifully lighted. In the kitchen demonstrations of electric cooking are being carried out, and are under the direction of a first-class cook. Electric laundry work is also shown.

A COUNTRY IN THE MAKING.[1]

THE Argentine Republic has recently celebrated the centenary of its existence as an independent State, and, in the national "stocktaking" which inevitably belongs to such an event, considerable attention has been given to education, as a result of which we have two large volumes of statistical records, and a third volume of monographs, on the various grades of educational work that come under the direction of the State.

Prior to its escape from Spanish control, such education as there was in the country was under clerical, and, for the most part, Jesuitical direction. In the ancient (Argentine) city of Cordova, the foundation of which by Peruvian Spaniards dates back to 1573, the Jesuits established a high school (*Colegia maxima*) in 1610, which Pope and King combined to raise to the dignity of a university very few years later. The university was for two hundred years the sole representative of higher studies. It was secularised in 1800, and a sister university was set up at Buenos Aires in 1821 by the recently organised Government.

It is interesting to note how world-wide was the influence of Napoleonic ideas. There was then no Department of Public Instruction, and the new university was entrusted with the duty of educational administration in the city and district. After various experiments in constitution-making, however, the influence of the great republic of the north made itself felt, and in the federal form of government which was completely adopted in 1860, the duty of providing primary schools was put upon the local legislatures, and a central Ministry of Public Instruction was also formed. It was not, however, until Sarmiento's presidency (1868–73) that the country really woke up to its educational needs. Sarmiento had been an exile for some years, and during that time Chile had sent him to Europe and the United States to study educational systems. He had met Humboldt, Guizot, Cobden, and Horace Mann, and entered upon his presidential period full of great projects for the development of national education. His influence led to greatly-increased grants from the central exchequer to the provincial governments, and to the establishment of a great training college for teachers on the model of similar institutions in the United States.

The degree of progress which has been attained in the provision of primary schools, and the vast difficulties of the Government, are best illustrated by the comparative number of children between six and fourteen who could not read or write (*illettrés*) in 1895 and in 1900. There were in the former year 57 per cent., and in the latter 32·6 per cent. Education is compulsory between six and fourteen; we may suppose that the children in school do not learn to read within a year, and so reduce the 32·6 to approximately 28 per cent.—not a bad result if we keep in mind the enormous territory and the sparseness of the population, immediately the precincts of the large towns are left behind. Uruguay is the only other South American State which comes approximately near to such a result; the number of illiterates rises to 80 per cent. in Brazil and 90 per cent. in Venezuela. In spite of what has been accomplished in the sphere of primary education, the cost to the State is very small in comparison with what is paid for the higher schools and universities.

Most of the secondary schools are under the direct control of the Central Government. They follow a five-year course preparatory to the university. As is the case in Austria, it is worthy of note that psychology is a subject of instruction in the last school year. The schools in Buenos Aires are magnificently housed; their equipment is costly, and their staffs are ample. The five schools cost the city more than 100,000*l.* in 1908. But in the smaller towns things do not go so well. The subjects are appropriated to chairs (*catedras*), the holders of which must give at least three hours a week instruction. They are for the most part occupied by local professional men, whose main interests are not, of course, in the school. There are two State high schools for girls, in Buenos Aires and in La Plata, but the majority of girls are educated in conventual institutions. The Jesuitical seminaries also attract many of the sons of the wealthier classes.

There are now three universities in the country, a third having been founded by the State of La Plata in 1906. This last foundation follows the United States model, with a supervising president who brings unity into the system of government by more or less independent faculties such as obtains in Cordova and Buenos Aires. All the universities are handsomely provided with funds. In 1908, Cordova received 55,000*l.*, Buenos Aires 90,000*l.*, and La Plata 86,000*l.* from the national exchequer. Nor is capital expense spared. The State has recently voted 1,200,000*l.* for various university buildings, including a new hospital for the medical school at Buenos Aires, and buildings at Cordova in celebration of the tercentary of its foundation.[1]

Vigorous life and a profound belief in education are obvious everywhere. Technical schools, a new public school on the English pattern, magnificent museums and libraries such as our great provincial cities may long yearn for in vain—all these are pointed to with legitimate pride. Here and there in the record one comes across interesting bits of heterodoxy, which bear witness to a healthy independence of view. "J'estime que l'institution des Kindergarten est une véritable hérésie pédagogique et un crime de lèse-enfance." This is startling, to say the least. Nevertheless, the volumes fill one with admiration for the pride and faith in the future of their country which animates their authors and the administrators whose work they record. J. A. GREEN.

[1] "République Argentine. Recensement général d'Éducation levé le 23 mai 1900." By Albert B. Martinez. Tome i, "Population Scolaire." Pp. xlii+448. Tome ii, "Statistique Scolaire." Pp. lxxiii+344. Tome iii, "Monographies." Pp. ii+702. (Buenos Aires, 1910.)

DR. F. W. PAVY, F.R.S.

ON September 19 the death occurred of Dr. Frederick William Pavy, F.R.S., in his eighty-third year. Dr. Pavy was born in Wiltshire in May, 1829, and was educated at Merchant Taylors' School. He subsequently entered Guy's Hospital, where he had a distinguished career, and in the course of his graduation at the London University took the exhibition and gold medal in materia medica, the gold medal in medicine, and honours in other subjects. He became a doctor of medicine in 1853. He studied physiology in the laboratory of Claude Bernard, in Paris, and soon began that prolonged research into the relation of sugar to the animal economy, in reference to the causation and treatment of glycosuria and diabetes, which terminated only with his life.

[1] *V.* article "Argentine Republic," Macmillan's Cyclopædia of Education."

Dr. Pavy's first communication to the Royal Society was in 1855, and was entitled "An experimental inquiry into the nature of the metamorphosis of saccharine matter as a normal process of the animal economy." In this he gave reasons for believing that the sugar formed in the liver is not entirely destroyed by combustion in the body, but is changed by means of fermentation. This was followed in 1858 and 1860 by accounts of an "Experimental inquiry into the alleged sugar-forming function of the liver." In these he demonstrated that the large amount of sugar found in the blood returning from the liver was not, as Bernard supposed, present during life, but was really the result of a transformation of the glycogen taking place with great rapidity after death.

In subsequent papers he showed the influence upon the formation of sugar in the blood, of the injection of alkalis, and of acids, into the circulation. Claude Bernard had shown that a lesion of a certain part of the fourth ventricle would cause glycosuria; in 1859 Pavy, in a communication "On the lesions of the nervous system producing diabetes," demonstrated that the same change in the urine was brought about by removal of the superior cervical ganglion, or the division of the sympathetic trunk in the neck. He referred this appearance of sugar to an alteration in the vasomotor apparatus of the liver. In 1863 he was led to ask why the gastric secretions did not in health digest the gastric mucous membrane itself; and from a series of ingenious experiments he drew the inference that this was due to the circulation in the stomach walls of an alkaline blood which was sufficient to neutralise the acid gastric juice, coming into contact with the mucous membrane.

In the same year, Dr. Pavy was elected a Fellow of the Royal Society, and so far as communications to this society were concerned he appears to have rested on his oars for several years. Not that he was idle; far from it. He was for a time demonstrator of anatomy at Guy's Hospital. Within two or three years of graduation, he was appointed lecturer on physiology and comparative anatomy, and he continued his lectures on physiology until 1878, for the last five years in conjunction with Dr. Pye-Smith. In 1859 he was appointed assistant physician to Guy's Hospital, and in 1871 he became full physician. In 1862 appeared his work entitled "Researches on the Nature and Treatment of Diabetes," and he soon acquired a large professional practice among sufferers from that complaint.

Dr. Pavy did not, however, confine himself to the subject of diabetes; he did valuable work in connection with the forms of functional albuminuria, and he wrote a "Treatise on the Function of Digestion." This was followed in 1874 by a "Treatise on Food and Dietetics," which was a standard book for many years. In 1890, at the age of sixty-one, he retired from hospital work at Guy's, but he still enjoyed a large private practice, held the offices of censor and Harveian orator at the Royal College of Physicians, and continued unintermittingly and with dogged perseverance his researches upon the destination of sugar and other carbohydrates in the animal system. In 1875 he read a paper before the Royal Society "On the production of glycosuria by the effect of oxygenated blood on the liver," and in the following ten years he read as many papers bearing on the carbohydrates and diabetes. He made many practical additions to the chemistry of the subject, and his introduction of an ammoniated cupric test in the volumetric estimation of sugar was undoubtedly of great value.

Dr. Pavy has made numerous other communications to medical journals on these subjects; he published in 1894 a "Treatise on the Physiology of the Carbohydrates," and in 1908 delivered three lectures "On the pathology and treatment of diabetes viewed by the light of present-day knowledge." In all this later work he insists on the fact that carbohydrates can be both derived from, and converted into, proteid, as one of great importance in relation to diabetes.

Dr. Pavy's work was well known abroad, and he was the recipient of several honours. He was a corresponding member of the Société d'Anatomie of Paris; and in 1908 the Academy of Medicine of Paris awarded the Godard prize to his work on carbohydrate metabolism on diabetes. In 1901 he was awarded the Baly medal by the Royal College of Physicians of London.

FREDERICK TAYLOR.

NOTES.

EXHAUSTIVE tests have been made during the last two weeks by Mr. A. W. Sharman with instruments invented by him for telephoning through water without wires. A small telephone station has been erected in a room in an hotel on the cliffs at Pegwell Bay, and the other station has been fitted up on a motor-boat cruising in various parts of the bay. The microphone used in speaking is connected in series with a battery of four or five dry cells and an impulse coil, the coil being of special construction and giving very short induced currents of high potential, which are communicated to the water by two wires connected to the terminals of the coil and terminating themselves in plates buried in the sand or submerged in the water. Two similar plates, connected direct with a very low resistance telephone receiver, enable the speech to be "picked up" at distances of a mile and more. The speech transmitted through the water has been very distinct, and the system has shown good possibilities of its being used as a means of verbal communication between two ships, such as a battleship and a submarine. The effect is very directional; and another advantage is that, with a small tuned buzzer, telegraphic signals can be transmitted through the earth or water for a distance of several miles; the primary energy required is extremely small, four watts sufficing to telephone over a distance of two miles. Experiments are also being made in combining with the Sharman instruments a sensitive telephone receiver invented by Mr. T. Thorne Baker, with which it is hoped the present range may be increased by 50 per cent. or more.

THE naval dirigible, an experimental airship which has been building at Messrs. Vickers' works, Barrow, for the Admiralty, during the last two years, was wrecked on Sunday, September 24, while being towed out into the centre of Cavendish Dock in preparation for a flight. The vessel, which is of the Zeppelin type, is 510 feet long, 45 feet in diameter, and of a capacity of 20,000 cubic metres. The rigid framework, containing seventeen separate gas-bags, is constructed of a new alloy known as "duralumin." Each of the gondolas, fore and aft, contains a 200 horse-power Wolseley motor, the motor in front driving two propellers on either side, and that in the rear driving one propeller placed behind the gondola. The accident started so soon as the order to begin to veer the bow round towards the centre of the dock was obeyed. The ship bulged and broke by her seventh, eighth, and ninth gas-bags, approximately in the middle. The outer fabric fortunately held, enabling both portions to be secured and eventually returned to the shed, without injury to the crew, though several men were obliged to swim for safety. The exact cause of the accident is unknown, nor is it likely to be made public. Structural weakness would seem

to account for it, coupled with the fact that the keel, which originally ran the length of the vessel between the two gondolas, had been removed in order to lighten her.

THE Aëronautical Society of Great Britain at a special general meeting held on Monday, September 25, passed resolutions repealing its old constitution, under which it has been governed for forty-five years past, and substituting a new one, which provides for the creation of a technical side in addition to the lay or members' side. Fellowships and associate fellowships are to be granted to those respectively of considerable eminence and of an acknowledged position in the science of aëronautics, and special encouragement is to be given to students, for whom there is a separate grade. The growth of aëronautical engineering as a profession is the chief cause for this change, which, it is hoped, will give a much needed fillip to aëronautical industry, besides protecting and fostering its interests. The new council was also elected at the meeting, and is composed of the following:—A. E. Berriman, Griffith Brewer, Captain A. D. Carden, T. W. K. Clarke, B. G. Cooper, J. W. Dunne, J. Dunville, J. H. Ledeboer, Captain E. M. Maitland, F. K. McClean, Lord Montagu of Beaulieu, A. Ogilvie, M. O'Gorman, F. Handley Page, Colonel H. E. Rawson, and Colonel F. S. Stone.

NEWS has been received at the Royal Geographical Society that the International Geographical Congress, which was to have been held at Rome next month, has been postponed until the spring of 1912.

THE Secretary of State for the Colonies has appointed Sir Ronald Ross, K.C.B., F.R.S., professor of tropical medicine in the University of Liverpool, to be a member of the Advisory Medical and Sanitary Committee for Tropical Africa, in succession to the late Sir Rubert Boyce, F.R.S.

MR. A. P. TROTTER informs us that his name has been attached to the Report of the British Association Committee on Practical Standards for Electrical Measurements without his authority, and doubtless as the result of a mistake. But it compels him to state that he withdrew from the committee in July, 1910, because he strongly disagreed with some of its resolutions and with the mode in which the business was conducted.

CIRCUMSTANCES have arisen which have led to the abandonment of the arrangements made to hold the autumn meeting of the Iron and Steel Institute in Turin. The meeting will be held, therefore, at the Institution of Civil Engineers, Great George Street, Westminster, on October 5. Among the papers which have been submitted, a selection of which will be read and discussed, may be mentioned:—Reports on the iron-ore resources of Italy: (*a*) Sardinia, by Ing. L. Testa, (*b*) Brembana Valley, by Cav. G. Calvi, (*c*) central Italy, by Ing. A. Ciampi, (*d*) southern Italy and the island dependencies, by Prof. G. la Valle; on the mechanical influence of carbon on alloys of iron and manganese, by Prof. J. O. Arnold and Mr. F. K. Knowles, of Sheffield; on the autogenous welding of metals, by Dr. Francesco Carnevali, of Turin; on the application of electric energy to the manufacture of iron and steel in Italy, by Cav. Ing. Remo Catani, of Rome; on the present state of the metallurgical industry of Italy, by Signor Comm. Luigi Dompé and Cav. Francesco Saverio Pucci, of Milan. Papers will be submitted also by Mr. E. Adamson, of Sheffield; Mr. L. L. Fermor, of Calcutta; Prof. Federico Giolitti, of Turin; Prof. F. Giolitti and Dr. Francesco Carnevali, of Turin; M. L. Grenet, of Argenteuil, France; and M. V. A. Kroll, of Luxembourg.

DR. C. H. WIND, professor of theoretical physics at Utrecht University, died on August 7, after a long illness, at the age of forty-three. Prof. E. v. Everdingen, director of the Royal Netherlands Meteorological Institute at de Bilt, sends us the following particulars of Dr. Wind's career and scientific work:—Cornelis Harm Wind was born at Groningen, and studied physics and mathematics there and at Leyden and Berlin (1886–95), and physical chemistry with van 't Hoff at Amsterdam (1895). He was then appointed lector in theoretical physics and physical chemistry at Groningen. In 1902 the Government, desiring to encourage the application of theoretical physics to the solution of meteorological problems, appointed Wind as director of the Meteorological Institute at de Bilt. As such he reorganised the practical work, devised schemes for extensions in terrestrial magnetism, seismology, and kite work, and introduced many improvements in the regular publications. In 1904, however, when the time for theoretical work had scarcely arrived, he was called upon to take the chair of theoretical physics at Utrecht, and accepted the invitation, not without much hesitation. Wind's theoretical work of the Groningen period promised a brilliant career. His work on magneto-optics led him to predict an analogue to Kerr's phenomenon, afterwards verified by Zeeman. Haga and Wind's experimental researches on diffraction of Röntgen rays induced him to investigate the explanation of diffraction phenomena generally. Other researches consider Gibbs's phase rule, the kinetic theory of gases, and the second law of thermodynamics. Also one part of Bosscha's text-book of physics was written by him in this period. Unhappily, at Utrecht his health began to give way and prevented further development in this direction. Nevertheless, he continued to show great interest in geophysical problems as a member of the board of visitors of the Institute for Marine Investigations, afterwards also of that of the Meteorological Institute. Those who met him at the meetings of the Permanent International Council for the Investigation of the Sea will remember his activity in organising the hydrographical work. His many friends and colleagues who remember his keen interest in their affairs and work whenever they asked his advice know that, though his life was too short, it was not in vain.

IN his pamphlet, "The Stone Age and Lake Lothing" (Norwich: Norfolk News Co., Ltd.), Mr. J. Chambers says:—"My intention was to write a brief notice of the flint implements I found lately when excavating in the bed of Lake Lothing, at Lowestoft." Beyond a few remarks on various methods of identifying stone implements, the author's intention has not been carried out. His remarks on the history of the lake are interesting, but he leaves the very subjects on which he has some valuable first-hand information to dabble in place-name speculations, the value of which may be estimated by his list of "acknowledged authorities."

IN the September issue of *Man* Messrs. W. L. H. Duckworth and L. R. Shore describe a collection of crania derived from the peat deposits, which are now deposited in the Cambridge University Museum. While, as regards the mammalian fauna, the type from the peat deposits is certainly distinctive, there is great diversity in the cranial forms. Two of these crania tend to intrude among those of the prehistoric age; but this association is with examples the Palæolithic origin of which is not universally accepted. It seems at the same time certain that this collection contains examples somewhat unusual when judged by the three standard tests—the calvarial height index, the bregmatic

angle, and the lambda angle—when compared with modern European crania. In view of the doubts still expressed by some authorities regarding the crania from Galley Hill and Brünn, the problem of the connection of them with the peat-deposit examples must remain somewhat uncertain.

The Museums Journal for September contains an interesting article by Mr. H. Stuart Page on the evolution of English pottery, with valuable suggestions for the preparation of a type collection. He begins his survey with the old English slip-ware made at the end of the seventeenth and the beginning of the eighteenth centuries. He points out that the advent of Oriental porcelain entirely changed the outlook of the English potter. This was introduced by the East India Company when the custom of tea-drinking was becoming established in this country, and we can easily realise how wonderfully beautiful these thin, white, glossy, transparent vessels must have appeared to people who were then daily using the home-made coarse utensils. From a valuable chart appended to this paper we can understand the subsequent course of evolution. In dealing with the preparation of a type collection, Mr. Page warns his fellow-curators that they must not attempt to compete with private collectors in purchasing specimens which from their rarity have acquired a high fictitious value. Only the educational needs of a museum should be kept in view, and a collection of less than a hundred pieces carefully selected, arranged in the position for which they were designed, and fully labelled, would, he suggests, be sufficient for the purpose. As the Board of Education is now prepared to give financial aid in the formation of such type collections, it is the duty of curators to select their examples with discrimination. Such a scheme should commend itself to those museums where space and funds are limited, and in those places where a large number of specimens already exist; the idea could be carried out so as to serve the place of an index to the main collection.

In *Phytopathology* (vol. i., No. 3), Mr. J. R. Johnston states that the *Bacillus coli* (the common microbe present in the intestinal tract of man and most animals), when inoculated into coconut plants, is capable of destroying the soft tissues. The *B. coli*, or a form indistinguishable from it, is also the cause of "bud-rot," a disease of the coconut plant.

Judging from the report for 1910, the Sarawak Museum seems to be doing its work, in the matter of the fauna and flora of Borneo, in a thoroughly efficient manner. In addition to duplicates, the museum contains 40,975 named specimens of Bornean animals, referable to 5852 species and subspecies. Besides these, there are between 4000 and 5000 forms not yet properly named. His Highness the Raja has sanctioned the building of a new wing, which when complete will make the museum two-thirds as large again as at present. Arrangements have been made for the publication of a Sarawak Museum Journal, of which the first part was expected to appear in February last.

Much interesting information with regard to the economic products of India is to be found in the report of the Industrial Section of the Indian Museum for 1910–11, more especially in the part dealing with the work of the laboratory. Among the items, reference may be made to the analysis of a sample of Para rubber, the yield of *Hevea brasiliensis*, grown at Darjiling, this rubber being of good quality. On the other hand, rubber from *Ficus altissima*, grown in Assam, proved unsatisfactory. The tree in question is referred to as *Ficus altissima*, Bl., var. *typica*, King; but such a reference, even if it be generally used in botany, is incorrect, as *Ficus altissima typica* (to use the zoological form of nomenclature) is clearly the original type described by Blanford. Experiments as to the suitability of Indian fish-oils for the dressing of jute are likewise discussed, and it has been found that such oils, which in some cases must be diluted with mineral oil, would be satisfactory for this purpose if they could be produced at a sufficiently low price. An outbreak of beri-beri in Bengal led to the analysis of samples of rice, which showed that while husked rice contained from 0·6 to 0·8 per cent. of phosphoric anhydride, "polished" grain contained an average of only 0·4 per cent., which in some samples was reduced to from 0·26 to 0·22 per cent.

To *The American Naturalist* for September Mr. T. Barbour contributes a translation of an important article, by Dr. P. N. van Kampen, on the zoogeography of the East Indian Archipelago, originally published in Dutch in *Natuurkundig Tijdschrift voor Nederlandsch-Indië* for 1909. By means of maps of the distribution of mammals, amphibians, and fresh-water fishes it is shown that Wallace's line "has no value as a zoogeographic boundary," and that nearly the entire eastern half of the archipelago must be regarded as a transition area between the Oriental and Australian regions, the boundaries of which cannot be defined. After reference to the theory that the Australian fauna came from South America, it is concluded "that in post-Cretacean times there was a broad connection between the three Greater Sunda Islands and Asia on the one hand, and between New Guinea and Australia on the other; that, further, also between the Sunda Islands and New Guinea a connection must have existed, which was really less easy to pass over." Celebes is considered to possess an impoverished Indian fauna, due to the absence of free connection with the larger western isles, this poverty being most noticeable in the case of fishes. Its fauna may be the result of the consolidation of smaller islands, which were supplied by feeding lines from islands to the south, north, and east. "It is peculiar that the truly Indian character of Celebes remained unsuspected so long; while, on the other hand, no one doubted, but rather laid stress upon, the Australian relationship of that vast easterly island, New Guinea, the fauna of which is fully as Indian as that of Celebes is Australian." An African element is supposed to be represented in Celebes by the black ape (Cynopithecus) and the babirusa, the former being considered to be related to the baboons and the latter to the wart-hog. The evidence for this seems, however, inconclusive.

The new regulations for recruitment of the Indian Imperial Forest Service are published in *The Indian Forester* (August), with some cogent criticisms not altogether favourable. The substitution of several recognised training schools in place of a definite establishment at Oxford does not meet with favour, but the appointment of a member, retired or active, of the Indian forest department as a controlling director is regarded as a hopeful arrangement. Coincidently the number contains a communication issued by the Government of India revising the regulations for the training of provincial candidates at the Forest College, Dehra Dun.

A revision of the small liliaceous tribe Nolineæ, intermediate between the Yucceæ and Dracæneæ, has been prepared by Dr. W. Trelease, and is published in the Proceedings of the American Philosophical Society (vol. l., No. 200). The author recognises four genera by the inclusion of the monotypic genus Calibanus, founded on Hooker's *Dasylirion Hartwegianum*. Ovary and fruit

furnish characters distinguishing the genera Nolina, Calibanus, Beaucarnea, and Dasylirion. The species are pronounced xerophytes with a succulent caudex; some of them reach tree size, as *Nolina longifolia* and *Beaucarnea gracilis* that are illustrated. The focal centre of the tribe lies on the Mexican tableland, with a distribution southwards to Central America and northwards to California and Colorado. Half the species are assigned to Nolina, and only seven are placed under Beaucarnea.

AMONG the sixty-eight parts mapped out in connection with the Clare Island Survey, one of the earliest and a most interesting number is the graphic account of the lichens contributed by Miss A. Lorrain Smith. The region of rock, moorland, and sea coast on Clare Island and the adjacent mainland is particularly favourable to their development. The seaward rocks are clothed with black *Verrucaria maura*; *Ramalina scopulorum* and *Ramalina cuspidata* grow within reach of the spray, and *Physica parietina* gives colour to the boulders; proceeding inland, *Lecanora parella* and *Lecanora atra* are first prominent, and then *Lecidea rivulosa*. The peaty soil carries fine growths of Cladonia and Stereocaulon, and in the grass species of Peltigera are abundant. The present list, not regarded as exhaustive, enumerates 280 species, of which only about thirty were previously recorded for the county, while the new records for Ireland approximate to this figure. The rarer species include *Arthopyrenia leptotera*, *A. microspila*, *Arthonia subvarians*, *Microthelia dissepta*, and the alpine *Pertusaria gyrocheila*.

THE reopening of the old alluvial goldfield in eastern Sutherland was referred to in NATURE of July 13 (p. 51). It was then remarked that gold was being obtained, but whether it occurs in paying quantities had still to be proved. Information recently received from the field shows that the experiment has been a financial failure, but fresh attempts are being made at another locality.

THE twelfth half-yearly review of mining operations in South Australia records the further development of the Tanami Goldfield in the Northern Territory, and states that instructions for the provision of a battery have been given by the Minister for Mines. The most important mineral product of South Australia is copper, and owing to its low price during the half-year copper mining had not been active. Further progress is being made in the development of the carnotite lode at Radium Hill, and the manufacture of gas fire-blocks has begun a fresh use of the extensive china-clay deposits of South Australia.

IN the September number of *The Scottish Geographical Magazine* there appears a paper on the plant geography of Ardgoil, a public park of the Corporation of Glasgow, comprising some 14,000 acres, bordering on Loch Long and Loch Goil. Maintained in its natural condition of a Highland estate, it offers an excellent field for the study of such problems; and Mr. T. Nisbet's paper, read to the geographical section of the Royal Philosophical Society of Glasgow, is an excellent example of the useful work which can be done in local investigations. The present distribution of trees and plants is compared with the records in early statistical accounts, and the controlling influence of the greater hillside and glen population which existed a century and more ago is pointed out.

IN the Proceedings of the Royal Irish Academy Prof. G. A. J. Cole describes the glacial features in Spitsbergen, and compares them with such as are to be seen in Ireland, where we associate with the waning of the Irish Ice age. The general appearance of aridity in the form and manner of weathering in Spitsbergen is very striking, and the action of penetrating water and repeated frosts leads to a rapid destruction of the rock, often forming cirque-like basins on the hill-slopes. Such cirques, illustrations of the arid type of weathering, Boulder-clay, and fluvio-glacial deposits are well shown by photographs taken by the author, who discusses the possibility of somewhat similar conditions having existed over Ireland during the Glacial period.

A CORRESPONDENT asks what is "teart land," for the investigation of which the Development Commissioners have made a grant. The use of the word "teart" in connection with certain soils was referred to in NATURE of November 3, 1910 (p. 25), and of May 11, 1911 (p. 364), both times in reference to Mr. C. T. Gimingham's very promising work on problems presented by such lands. Dr. E. J. Russell informs us that the word is used to denote certain pastures in Somersetshire on which cattle "scour," or get diarrhœa badly, whilst on other pastures round about they remain perfectly healthy. Botanical examination of the pastures reveals nothing that can account for the scouring, nor is there any evidence of disease organisms. Only the Lower Lias formation is affected, alluvial pastures all round a Lias pasture being quite sound. The whole problem is very baffling and extraordinary, but it is typical of many other pasture problems which require investigation.

IN the August number of *La Géographie* M. Paul Mougin discusses the snowfall in Savoy. The material available includes many references to the deficiency or excess of snowfall in different years, and by research among the documents preserved in the official centres of the province a large amount of information has been collected which reaches back for many years. But such data are but approximate, and are only available for exceptional years; nevertheless, from 1773 onwards the dates of the earliest and latest snowfalls have been recorded at Annecy. Taking the mean dates for each twenty-five years, there seems to have been a maximum annual duration of snow in the period 1801–25, since when it has decreased. It is pointed out that this corresponds with the maximum extension of the glaciers in 1818–20, and do not contradict their retreat, which commenced after 1863. From 1853 the depth of snow falling in each year has been recorded at Annecy, and since 1900 the Administration des Eaux et Forêts has considerably increased the number of observing stations. From such data M. Mougin discusses the increase of snowfall with altitude, and the marked increase recorded in passing from north to south. There are also localities of exceptionally heavy snowfall which are not on the highest parts of the mountain range.

THE interesting weather charts of the North Atlantic for September 7–13, prepared from radio-telegrams and other data, and published in the first issue of the valuable monthly meteorological charts for October by the Meteorological Office, show that the distribution of barometric pressure was subject to considerable variation. The chief features were the movement of high and low systems, generally of small intensity, across America to the Atlantic, and their subsequent tracks across the ocean. At the close of the period the eastern half of the Atlantic was under the influence of a very large high-pressure system extending from Greenland and Iceland southward to the edge of the tropics, and the office was enabled to predict successfully a continuance of these conditions for some days. On the same chart it is notified that the French Meteorological Office has commenced the dispatch of wireless messages

from the Eiffel Tower, at 11h. a.m. daily, for the benefit of shipping in the Atlantic. The reports consist of barometric readings, wind direction and force, and state of sea at six stations in western Europe, Iceland, Azores, and Miquelon (Newfoundland), to which a general summary of the weather is added, *e.g.* "Anticyclone over central Europe, fine weather general; depression west of Iceland, travelling toward the east."

IN view of the extensive use which is made of sulphur as an insulator in electroscopes used in ionisation observations, a note in the August number of *Le Radium*, by Mr. F. W. Bates, of the University of Montreal, on the effect of light on the insulating properties of sulphur will be read with interest. Mr. Bates finds that when exposed to light sulphur becomes slightly conducting, the conductivity increasing as the intensity of the light increases. This property, he finds, is shared to a small extent by ebonite, but amber appears unaffected by light. He considers that the importance of the subject justifies a more extended study of it, and this he has commenced.

PROF. A. RIGHI has two interesting papers in vol. xiv. of the *Mem. della R. Accad. di Bologna*. The first deals with the ionisation produced by the magneto-kathode rays. It is found as the rays are more strongly developed, by increasing the axial magnetic field, that the ionisation at a given point in their path is diminished. The explanaton of this effect follows simply from the mode of formation of the rays; the field holds in loose combination pairs of oppositely charged ions which would otherwise escape from each other's attraction, the number of free ions in the discharge tube is therefore diminished. Sir J. J. Thomson has shown how complex are the phenomena in the region in which the canal rays are usually studied; it therefore seems possible that other plausible explanations could be given of the observed effects. The second of the two papers deals with less explored ground, viz. the influence of a magnetic field on the sparking potential. The results here are so complicated that Prof. Righi thinks more data will have to be collected before an explanation can be given. As the magnetic field is increased the sparking potential falls to a minimum, then rises to a maximum, and finally decreases very slowly. The magnetic and electric fields are parallel. Of other papers of physical interest, one by Prof. Amaduzzi deals with the photo-electric effect in selenium, while Prof. P. Burgatti treats of the vortical motion of a liquid, using vector analysis.

WE have received from the Patent Office Library a new "Subject List of Works on Chemistry (including Alchemy, Electrochemistry, and Radio-activity) in the Library of the Patent Office." It is a work of 218 pages, and supersedes a list published in 1901. A valuable feature of the list is the use of the dates of the volumes as one of the chief items in the scheme of classification; under this system it is easy to follow the gradual development of a subject or process, and new publications fall naturally into their proper places at the end of the series. The classification is somewhat complex, and some practice would be needed to trace quickly the volumes that one wished to consult; but this is perhaps inevitable in view of the bewildering array of books, journals, theses, dictionaries, and pamphlets which compose the literature of chemistry.

A PAPER by M. Paul Sabatier on hydrogenation and dehydrogenation by catalysis has recently appeared in the *Revue Scientifique*. Originally delivered in the form of a lecture to the German Chemical Society, the paper contains a review of the new and important branch of organic chemistry which has been developed during the past twelve years by the author and his colleagues. The catalytic action of the metals, and especially of finely divided nickel, has been utilised in a very large number of organic changes, and has proved of peculiar value in the addition and removal of hydrogen; more recently the catalytic influence of a number of oxides, such as thorium dioxide, has been investigated, and has proved to be of great service in effecting processes of condensation, such as the conversion of acids into ketones, and of alcohols into thiols, esters, ethers, and amines. The summary now given is both opportune and useful.

THE solubility of hydrogen in copper, nickel, and iron is the subject of a communication by A. Sieverts to the current number of the *Zeitschrift für physikalische Chemie*. The solubilities were studied for pressures up to 1½ atmospheres, and over the temperature range 400° C. to 1600° C. For a given temperature and pressure it was found that the amount of gas taken up per unit weight of metal was independent of the metal surface. At constant temperature the solubility in both solid and liquid metal is approximately proportional to the square root of the gas pressure; at constant gas pressure the solubility of the hydrogen increases with the temperature, a sudden increase in the amount absorbed taking place at the melting point of the metal. As a consequence of the latter property, there is a spitting when the metal solidifies, copper giving off at its melting point about 2 volumes of hydrogen, iron 7 volumes, and nickel 12 volumes.

THE August issue of the Journal of the Franklin Institute contains a paper by Dr. Charles Baskerville on the chemistry of anæsthetics. In the case of chloroform especially, and to a less extent in the case of other anæsthetics, it is important not merely to ensure the initial purity of the material, but also to store it under such conditions as to prevent the formation of deleterious substances. The deterioration of chloroform is mainly due to oxidation, as shown by the equation

$$CHCl_3 + O = COCl_2 + HCl.$$

This change is usually checked in the case of anæsthetic chloroform by the addition of alcohol; and it has been shown that the initial oxidation of the mixture proceeds entirely at the expense of the alcohol, and that the chloroform is not attacked until later. Nevertheless, it is desirable to restrict oxidation by storing the liquid in small bottles which can be opened as required, and to make use of anactinic glass; it has even been suggested that the liquid should be stored in contact with nitrogen, and drawn off by means of a syphon, in order to avoid all risk of oxidation.

AN article in *The Engineer* for September 22 deals with hydraulic excavation on the Panama Canal. The method has been borrowed from hydraulic gold-mining as practised in California, and has been used on the largest scale in the area extending southward from the lower locks at Miraflores to opposite Corozal. Some 330,000 cubic yards of alluvial material were disintegrated between October and February last. The chief difficulty experienced during the progress of the work was the frequency with which limbs and trunks of cocoanut trees, washed from the mud several feet below the surface of the ground, were drawn into and choked the suction pumps. When this occurred, a coloured workman dived to the mouth of the pipe and extracted the débris. The cost sheets indicate that the economy of this method of excavation is undoubted.

AN illustrated description of the Trollhättan Hydro-electric Power Station, Sweden, appears in *Engineering* for September 22. This station will represent, when com-

pleted, an aggregate of 100,000 horse-power, half of which has just been installed. The Swedish State now controls the entire water-power of the Göta River, which connects Lake Vänern, the largest lake in Sweden, with the sea, there being a difference in level of 144 feet, of which 108 feet occur in the Trollhättan Falls. The present low-water volume is 11,520 cubic feet per second, and the high-level volume of water is about 32,400 cubic feet per second. When Lake Vänern is regulated, the State will be able to reckon on an aggregate of not fewer than 200,000 horse-power at the Göta Falls. The district is at no great distance from Gothenburg, and is in the midst of a populous part of the country. Francis turbines of a nominal capacity of 10,000 horse-power and a maximum capacity of 12,500 horse-power have been installed. The generators produce three-phase current, twenty-five periods, and 10,000 volts. The energy is distributed partly at 10,000 and partly at 50,000 volts.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR OCTOBER:—

Oct. 1. 12h. 4m. Uranus in conjunction with the Moon (Uranus 4° 44′ N.).
4. 5h. 0m. Venus stationary.
5. 15h. 0m. Uranus stationary.
10. 6h. 28m. Saturn in conjunction with the Moon (Saturn 4° 27′ S.).
11. 17h. 52m. Mars in conjunction with the Moon (Mars 4° 21′ S.).
17. 12h. 0m. Mars stationary.
,, 19h. 0m. Neptune at quadrature to the Sun.
19. 12h. 0m. Uranus ,, ,,
21. 15h. 55m. Sun eclipsed, invisible at Greenwich.
22. 4h. 0m. Venus at greatest brilliancy.
23. 9h. 0m. Mercury in superior conjunction with the Sun.
,, 11h. 31m. Jupiter in conjunction with the Moon (Jupiter 2° 40′ N.).
27. 14h. 0m. Neptune stationary.
28. 20h. 40m. Uranus in conjunction with the Moon (Uranus 4° 48′ N.).

ANOTHER NEW COMET, 1911*f*.—A telegram from the Kiel Centralstelle announces the discovery of a new comet by M. Quénisset, at Juvisy, on September 23. Its position at 10h. 25m. (Juvisy M.T.) was

R.A. = 14h. 24·8m., dec. = 75° 4′ N.,

and its daily movement was +3·8m. in R.A. and −2° 11′ in declination.

We also learn that this comet was discovered independently by Mr. Francis Brown, of Lee, S.E., on Sunday, September 24, at 9 p.m. Mr. Brown gives its position then as R.A. = 14h. 37m., dec. = 73° 40′ N.

The magnitude of the new comet is given as 7·5, and, as it is situated so high up in Ursa Minor, it should not prove a difficult object.

DISCOVERY OF BORRELLY'S COMET (1905 II., 1911*e*).—According to a telegram from the Kiel Centralstelle, the credit of rediscovering Borrelly's comet, for which, as we mentioned in last week's issue, M. Fayet has just published search-ephemerides, belongs to Mr. Knox Shaw, of the Helwan Observatory, Egypt, who found it in R.A. 3h. 46m. 20s., dec. −32° 54′, at 15h. 5m. (Helwan M.T.) on September 19. The discovery was probably made on a photograph taken with the Reynolds 30-inch reflector, which, it will be remembered, was the first instrument to secure a recognised photograph of Halley's comet; the magnitude is given as 13·0.

M. Fayet gave three ephemerides based on the assumptions of perihelion passage taking place on December 18·6, 14·6, or 22·6; the observed position is more nearly in accordance with the first of these. He also shows that by the middle of October the quantity $1 : r^2\Delta^2$ will be as great as it was at the time of the comet's maximum brightness in 1905; after that it will increase considerably, from 0·57 to 1·90, so that the conditions of this return will be much better, for southern observatories, than at the previous apparition.

THE KIESS COMET, 1911*b*.—Numerous observations of comet 1911*b* are published in No. 4525 of the *Astronomische Nachrichten*, all of which direct attention to the diffused nebulous character of this object. On August 11 Herr Ernst, at the Königstuhl Observatory, found the diameter to be 12′, the coma appearing slightly elongated in the direction N.-S., and the nucleus being easy to see.

Dr. Konkoly at O'Gyalla found the three hydrocarbon bands to be very bright, their relative intensities, reckoning from the red, being 0·6, 1·0, and 0·3; a short continuous spectrum passed through the middle of the lines.

Dr. Holetschek gives a list of brightnesses of the whole comet and the nucleus as observed at Vienna, the maximum brightness, 5·5 mag., of the former occurring on August 3, although the greatest estimated magnitude of the nucleus, 7·0, was recorded on July 18.

Photographic observations at Innsbruck indicated possible changes in the extent of the tail on successive nights, and Herr Prey records tails up to ½° in length. Considerable changes of form are also recorded by M. Quénisset, who reproduces an excellent photograph of the comet on a plate accompanying the September number of *L'Astronomie*. This was taken at Juvisy on July 29 with an exposure of 78m., and shows a tail 5½° long issuing as a hard, fine streamer from the centre of the coma; but M. Quénisset records that on August 6, when the tail was fainter and 2½° long, it was strongly eccentric, and certainly appeared to emerge from the northern edge of the coma.

In *La Nature* for September 23 Dr. Mascart discusses the observed form and spectrum of this comet, and directs attention to the method of repeated copying by contact for the purpose of strengthening the fainter details on comet photographs. The advantage accruing from this process is well illustrated by two reproductions of one of the photographs of Halley's comet which he took at Tenerife in April, 1910. That direct from the original negative is very weak and shows little tail, whereas the one from the recopied negative is much stronger and shows a fair amount of tail.

BROOKS'S COMET, 1911*c*.—M. Quénisset also reports that he has taken several photographs of Brooks's comet, which is now such a prominent object in Boötes. Photographs taken on August 24, 25, and 27, the last with 5h. exposure, show a head having a diameter of 12′ or more in a direction perpendicular to that of the tail; the latter feature shows a length of 4°, and is slightly divergent.

THE SPECTRUM OF MOREHOUSE'S COMET (1908*c*).—Count de la Baume Pluvinel and M. Baldet have a paper in No. 2, vol. xxxiv., of *The Astrophysical Journal* in which they discuss twenty-eight negatives of the spectrum of Morehouse's comet, which they photographed at the Juvisy Observatory during October and November, 1908.

The discussion is a very thorough one, in which the authors show that the spectrum of the comet agrees excellently with the spectrum discovered by Prof. Fowler. The doubling of the bands in the cometary as in the laboratory spectra is very striking. The four band-spectra disclosed are attributed by the authors to carbon monoxide, nitrogen at low pressure, cyanogen, and carbon; in addition, there are some fainter radiations, not yet origined. While cyanogen and carbon were restricted to the head, carbon monoxide and nitrogen were distributed throughout the comet. The bands were also studied from the point of view of "series," and the authors find them classifiable into a "strong" and a "weak" series. An excellent reproduction of the spectrum accompanies the paper.

METEOR OBSERVATIONS.—A number of observations of bright meteors are reported in No. 4525 of the *Astronomische Nachrichten*. Mr. Denning gives the paths and velocities of eleven meteors seen in July and August, Prof. Konkoly reports 200 meteors seen at Nagy Tagyos during the July and August swarms, and Herr Dziewulski gives particulars of two bright meteors seen at 11h. 55·6m. (M.E.T.) and 11h. 57·6m., respectively, on July 6. At Cracow the apparent paths were 317°, −2° to 350°, +10° and 307°, +23° to 327°, +46°, respectively; the first lasted

ten seconds, and was three times as bright as Venus, while the second was as bright as Venus and endured for four seconds.

Mr. W. Moss reports that he observed a first-magnitude meteor at South Kensington at 10h. 1m. on September 26. The meteor was moderately rapid, yellowish in colour, and left no trail. Its apparent path was from 40°, +40° to 52½°, +32½°.

THE BRITISH ASSOCIATION AT PORTSMOUTH.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS (ABRIDGED) BY THE RIGHT REV. J. E. C. WELLDON, D.D., PRESIDENT OF THE SECTION.

An Educational Review.

IT is my duty, as it is my pleasure, to express my cordial thanks to the council of the British Association for the honour it has done me in asking me to occupy the presidential chair of the Educational Section at the annual meeting. It has remembered what I was almost beginning to forget—that I was once a schoolmaster. Yet perhaps he who has once been a schoolmaster can never entirely lose the scholastic temper or, at least, I am afraid, the scholastic manner. Some slight comfort, however, I find in reflecting that there is probably no profession which has been adopted and, I must regretfully add, has been abandoned, by so many distinguished men and women as the educational. It happened to me at one time to examine for a special purpose all the lives recorded in the "Dictionary of National Biography"; and the number of the persons who were there stated to have been more or less constantly engaged in tuition was not less surprising than pleasing to an old schoolmaster. Apart from such persons as were born, in the proverbial phrase, with a golden spoon in their mouths, it is safe, I think, to assert that one out of every three or four eminent Englishmen has at some time or other been a teacher. Nor is this the truth in England or in Great Britain alone; it is true everywhere. Not to speak of lifelong educators or of persons whose principal work was done in education, there occur to me the names of such men as Isocrates, Aristotle, Origen, St. Jerome, Cardinal Wolsey, Erasmus, Milton, Rousseau, Thomas Paine, Dr. Johnson, Diderot, Cardinal Mezzofanti, Mazzini, President Garfield, Emerson, and Carlyle, who were all content at one time or other to make a scanty living by teaching.

Perhaps the fact that so many persons have taken up education simply as a means of livelihood is the reason why there have been so many educational failures. In no profession have good men and good women done so much lasting harm, or have done it so often without being aware of it, as in education. For an educator, like a poet, is born; he is seldom made: if he is deficient in discipline or insight or sympathy, they are hard to win by practice; harder still is it to win the passion for young souls; yet the educational profession demands enthusiasm above all other qualities; and I used sometimes to say to young candidates for office at Harrow that, unless a man honestly felt he would sooner be a teacher of boys than a Cabinet Minister, he would not be a master altogether after my own heart.

Yet the educational profession in itself, if it is not the most striking or shining in the eyes of the world, may be said to be the most inspiring and the most satisfying of all professions. It is the only profession which is naturally and necessarily concerned with all the three elements of man's composite nature, his body, mind, and spirit. It aims immediately and instinctively at the two highest objects of human aspiration, viz. the diffusion of knowledge and the promotion of virtue. Nor does any schoolmaster rise to the full height of his own calling unless he realises that his true object is to prepare his pupils, in all their faculties and in all the relations of their after-lives, for good citizenship. I cannot help thinking that a teacher who ignores or neglects the spiritual side of his pupils falls as far short of the scholastic ideal as if he were to think little or nothing of their bodies or their minds. The educational profession, when it is rightly understood, is capable of conferring signal benefits upon the community at large. There is an Oriental apologue which tells that in a time of grievous drought, when the king had vainly called upon the wizards, astrologers, and magicians to bring down rain upon his country, one humble unknown man at last stood forth to pray, and at his prayer the heaven above grew dark with clouds, and there was a great rain; the king desired to know who and what was he that had prevailed alone with God, and the answer was, "I am a teacher of small boys."

Education, as has often been said, is to-day in the air. More and more deeply the civilised nations of the world, and among them, at last, even Great Britain, are coming to realise that in the future the battle will be, not to the swift nor to the strong, but to the highly educated. It is the nation of the highest intelligence and widest cultivation which will assert its pre-eminence in the coming days.

But before any attempt can be made to criticise the existing educational system or want of system in Great Britain, and especially in England, it is necessary to state the principles underlying all true progress or reform in education. In the briefest possible language they are, I think, these:

(1) That every child shall enjoy the opportunity of developing in full measure the intellectual and moral faculties with which God has endowed him or her.

(2) That no difference of opportunity, or as little difference as possible, shall exist between the richer and the poorer classes of society.

(3) That the supreme object of education is to provide good citizens—citizens who, in Milton's stately language, will be able to "perform justly, skilfully, and magnanimously all the offices, both public and private, of Peace and War."

(4) That, as the personal influence of the teacher is a potent factor in education, it is the business of the State to ensure the highest possible efficiency, not only of intelligence, but of character, in the men and women who adopt the educational profession as their life-work.

It seems to me that all the educational questions of the day may naturally be ranged under these four heads. The first includes physiology and psychology as subjects directly bearing upon the teacher's art, the study of individual character, the size of classes, the specialisation of studies, the opportunity of self-culture, the time-table and the constituents of the curriculum, above all, the practical insight by which a teacher discerns, and the sympathy by which he or she encourages, the signs of genius or talent, even when they are overlaid by many faults and failings in a pupil. There is no more humiliating reflection than that teachers have so frequently been blind to the promise of distinction in their pupils. Of the public schools especially it is only too true that they have been, and in some degree still are, the homes of the average and the commonplace. They have applauded mediocrity if it conformed to the rules made by the masters for boys, and the yet stricter rules made by boys for one another; they have been not only oblivious, but even contemptuous, of such conduct as was felt to be a departure from, if not a reflection upon, the established norm of public-school life.

The second head includes such difficult matters as the *carrière ouverte aux talents*, the ladder set up from the lowest educational standard to the highest, the provision of scholarships, the equalisation, so far as possible, of the conditions under which boys and girls compete for pecuniary and other rewards, the danger of social exclusiveness in schools and colleges, and the appreciation of qualities, other than mere learning, as adapting students for their parts at home and abroad in after-life.

Under the third head, if it be granted that citizenship is, or ought to be, everywhere the educational goal, it follows that the teacher may not unfairly claim from the State the opportunity of giving such an education to children, especially in the wage-earning class, where parents are tempted to take their children away from school at an early age in the hope of making them contributors to the family purse, that it may not be hopeless

to implant in them a certain knowledge, and with it that love of knowledge without which education, so soon as it ceases to be compulsory, is only too apt to become a negligible factor in the citizen's life. It follows, too, that where the interest of the State is not wholly connected with the interest of the parent, or the class, or the Church, some degree of regard for the State will ultimately prove to be a not unjust condition of receiving public money.

Yet, again, a sense of the importance attaching to the personal and professional qualities of the teacher leads almost necessarily to an insistence upon official registration as a condition of undertaking educational work, upon the training and testing of teachers by all such means as are suitable to prepare them for their responsible duties, and upon pension schemes for facilitating the retirement of teachers when they have lost or are losing their vigour and have earned a period of repose. For education is a science; it is exacting, as all sciences are; and while the educational profession needs to be made as attractive as possible, especially in days when so many other professions enter into competition with it, and while it loses attractiveness if teachers, both men and women, are compelled to retire from it at too early an age, yet it is obviously wrong to sacrifice the many to the individual or the scholars to the teacher by obliging a schoolmaster or mistress to continue in office when he or she is no longer able to perform the duties of the scholastic calling with full efficiency.

More than forty years have elapsed since the passing of the Education Act of 1870. That Act was a signal legislative achievement; it still reflects lustre on the names of Mr. Gladstone and Mr. Forster. In the intervening years it has been subjected to severe controversy, not so much on educational as on ecclesiastical grounds. It has undergone some grave modifications at various times, especially in 1902. But, after all, the main principles embodied in the Act of 1870, viz. that education is a national concern, that the children are the greatest asset of a State, and that it is the interest no less than the duty of the State to provide, or to see that provision is made, for the education of all children in elementary or other schools, have not been, and in all probability will not be, seriously challenged.

The Act of 1870 has proved to be a great moral reform. It lifted the nation as a whole to a new level of self-respect. For the child who has acquired even such elementary learning as is popularly symbolised by the "Three R's" is a higher being than the child who cannot read or write. The elementary-school teacher, not in denominational schools alone, has been a missionary of civilisation, and, I think I may say, of Christianity, in many a dark region of many a populous city. I have been told that to the influence of the Board Schools in East London was traceable a marked advance among children in kindness to the lower animals. Any disparagement or depreciation of the Education Act of 1870 is little less than treason to the moral interests of the people at large.

But it is permissible to inquire what fresh light has been shed by the experience of forty years upon the established system of elementary education in England.

Perhaps the two dangers most evident at the present time are the tendency of the Board of Education towards bureaucratic control over all the schools coming under its jurisdiction, and the habit of imposing upon the local education authorities, whether by Act of Parliament or by ordinance of the Board of Education, a number of new duties without ensuring any corresponding increase of the public funds which are placed at their service.

It is idle, and it would probably be foolish, to resist the concentration of educational authority in the Board of Education. There are signs that the Board will before long exercise a direct influence even upon the great public schools. But who or what the Board of Education is remains somewhat of a mystery. It is too apt to mean a subordinate individual acting in the name, but without the knowledge, of his superiors.

The Board may have stereotyped elementary education overmuch; it may have laid down too rigid rules or have administered its own rules with too much rigidity; it may have set an excessive store by results which could be easily tested by examination, forgetting that the best and most lasting results of the teacher's influence are just such as cannot be easily weighed in the examiner's balances. But there can be no doubt that the control of the Board has exercised a wholesome influence upon the less satisfactory schools. It assures at least a minimum of efficiency. But the maximum of efficiency lies beyond the power of the Board. It depends upon the close, intimate, sympathetic, personal relation of the teacher to his or her pupils.

Nor, again, is there any doubt of the advantage arising from the gradual pressure of one and the same education authority, not only upon all schools of the same type, but upon schools of different types in the educational field. It is well that elementary schools should within certain limits exhibit something like uniformity of system; it is well, too, that the ladder by which students rise or may hope to rise from the lowest to the highest rungs of educational competency should be so set up as to make the process of climbing them no more difficult than it must needs be. But freedom, spontaneity, individualism, have been the rule in all departments of English life. No power can be more chilling in its effect upon intellectual enthusiasm than the dead hand of a code. Individualism with all its faults is better suited than the rigidity of the French or the formality of the German educational system to the hereditary genius of the English people. It is necessary, therefore, that the control of the Board of Education, while it is definite, should be as elastic as possible.

Again, the State has laid upon the local education authority the duty of supplying the necessary accommodation in elementary schools, except so far as it is supplied in non-provided or denominational schools through the agency of voluntary subscriptions. But it has scarcely taken account of the difficulties lying in the way of an education authority which can issue no precept of its own. Every education committee in England to-day is harassed by the obligation of persuading a body so hard-hearted as a city council, which is naturally inclined to look upon economy with more favour than upon education. The antagonism between the schools and the rates remains constant. Happy indeed is the education committee in a city where the council rises above the temptation of regarding education as an extravagance or a luxury.

The provision of free meals for hungry children is an admirable reform. For if children under the law must go to school, they cannot go with any advantage if they are hungry. But free meals cost money; and the money spent upon the meals may easily be deducted from the total sum which is spent, or ought to be sepent, upon education.

Not less admirable a reform is the physical inspection of children in elementary schools. Educational as well as medical science has learnt that hygiene is a powerful factor in the success of schools. But it is necessary to pay for a doctor's time and a doctor's skill; and if the physical welfare of the children is improved by medical attention, it is possible that their mental welfare may be impaired for lack of money.

It must be added that, in proportion as Education Committees undertake and prosecute the benevolent work of caring for the crippled and afflicted children of the country, their just demands upon the public purse will necessarily become more pressing.

Upon the whole I am not disposed to criticise the education which is given in the different standards of elementary schools. It is not, I think, ill adapted to the twofold object of preparing the children for their normal duties in after-life, and of offering to especially intelligent children the chance of rising to a higher position than that in which they have been brought up. But no teaching, however reasonable in itself, can be properly imparted where the classes of children are too large. If I have learnt any lesson by my educational experience, it is that difficult cases—and these are the cases which try the teacher's skill—need a great deal of individual time and thought. I used to feel, when I was a schoolmaster, that there were not more than two or three of my pupils whom I did not think I could have helped and possibly saved, had it been in my power to spend sufficient thought and time upon them. It is overcrowding which is the difficulty in schools as well as in homes; and I do not believe that any schoolmaster or schoolmistress can do full justice to a class of more than twenty or at the most twenty-five small children.

But this, again, is a matter of expense, and as a matter of expense it touches the rates.

Upon the whole, too, I do not regret the substitution of Education Committees for the original School Boards. It is true that the ideal picture of School Boards consisting of educational experts who cared pre-eminently or exclusively for the educational needs of their city is naturally pleasing to the imagination. But the School Board, with its power of invading the public purse, lent itself to friction with the civic authority. At present the Education Committees connect the education of a city by a direct personal chain with its civic administration; and if the civic element upon the Education Committees should ever seem to fail in educational knowledge or interest, the opportunity of coopting educational experts, and among these experts men and women who might often shrink from the ordeal of a hotly contested election, would seem to afford a sufficient guarantee against indifference.

But after some careful consultation with persons who in Manchester and elsewhere have studied for many years the problem of public elementary education, I have been led to the conclusion that the reforms needed at the present time are principally the following:

The control of the Board of Education over local education authorities has become too strong and too stringent. It is probably stronger and more stringent now than it has ever been since 1870. It would be wise, I think, to leave or to place greater administrative power in the hands of the local education authority. Local authorities understand local needs. So long as they do not depart from the general principles laid down by the Board of Education, they should be free to expend each its share of the public monetary grant in the way which they hold to be best for their own communities.

I see no need for a dual system of inspectors in elementary schools, and I think it tends to the interference of H.M. inspectors with details upon which their judgment is sometimes more confident than their knowledge is profound.

It is difficult in speaking of inspection to refrain from all allusion to the notorious circular letter which was issued some time ago in the name of Mr. Holmes. That letter was not, I think, so wrong in sentiment as in language. Inspectors chosen from the ranks of the elementary-school teachers may be deficient in breadth of sympathy, as other inspectors educated in the ancient universities may be deficient in practical experience. It is much to be hoped that the unnatural contrast between the antecedents of two classes of inspectors will pass into the background, and that the duty, which lies upon all education authorities, of appointing the best men or women as inspectors, whatever anyone's antecedents may have been, will regulate all appointments in the future.

The period of a child's school life is now too brief. There should, I think, be a universal minimum age at which children may leave school. It should probably be fourteen years. But whatever that age is, it should be absolute. It should be wholly independent of local by-laws, of the passing of standards, or of attendance at school before the age of fourteen.

The question of evening schools is fraught with difficulty. To make attendance at such schools compulsory would be to run a serious risk of over-pressure. It is probable that sympathetic cooperation between local education authorities and the employers of labour in the locality will in this matter afford the best hope of success. For it is the interest of the employers themselves that their employees should not cease to improve themselves in knowledge so soon as they leave the elementary schools.

The need of the local education authority for increased financial help out of public funds was recognised, I think, in Parliament during the debates on the last Education Bill. The State cannot make fresh demands upon the education authorities without granting them fresh funds. Yet there can be little doubt that the feeding of necessitous children and the care of the epileptic, feeble-minded, and crippled children will soon or late become duties imposed by Parliament on all local education authorities.

Lastly, the connection between the elementary school and the university or the technical school should be made complete. At present the elementary school provides education for children up to their fifteenth year. The university or the technical school does not admit pupils under sixteen years. But education, when it is once broken, is hard to resume. The educational system, if it is to be efficacious, must be continuous.

A public elementary system of education must be complete in itself, so far as it prepares children physically, intellectually, and morally for the affairs of life. But it must not lose sight of the possibility that some, and those the most promising, of the children educated in elementary schools will deserve to rise to a higher than an elementary educational standard.

It is probable that the ascent of pupils from one class of school to another will become more usual in future years. This ascent will be effected or facilitated, as to some extent it already is, by the provision of free places, bursaries, exhibitions, and scholarships. Even now boys educated in elementary schools have attained the highest honours in the ancient as well as in the modern universities. Some such boys have won admission to the public schools, and among these schools to boarding schools as well as to day schools. Whatever amount of social exclusiveness may still apparently linger in that most truly democratic of English institutions, a public school, it seems to me impossible that in a democratic age there should ultimately remain any school which will not open its doors to pupils who are drawn from every social section of the community. In the education of girls, the schools of the Girls' Public Day School Company and other similar schools, whether publicly or privately governed, have done much to mitigate, if not to dissipate, the social differences among girls living in the same locality.

But the agencies by which children of comparatively poor parents have in the past been enabled to receive an education in the schools, and indeed in the universities, of the rich are, I am afraid, coming to be gravely abused. Scholarships and exhibitions were designed to remedy the disadvantage of the poor, not to accentuate the privilege of the rich. To confer pecuniary rewards upon boys and girls whose parents can well afford to dispense with them is to foster a double abuse. It is to spend money where money is not needed, and to withhold money where it is needed. Yet in the public schools, and to some extent in the universities, scholarships and exhibitions tend to become the perquisites of the rich. In the field of secondary education the competition for scholarships and exhibitions has become so severe that scarcely any boy in the examination for them stands a chance of success, except at the cost of three or four years spent beforehand in an expensive preparatory school. But as rich boys are the only boys whose parents can afford this preparatory expenditure, it follows that rich boys are generally the successful candidates for scholarships and exhibitions. The evil is scarcely capable of exaggeration. It were bad enough that a rich boy, if he competed on equal terms with poor boys, should obtain a pecuniary reward which they do, and he does not, need for educational purposes. But when it is the rich alone who enjoy the opportunity, or the most favourable opportunity, of winning the pecuniary rewards which were justly intended for the poor, a case for drastic reform seems to be made out.

At the ancient universities the sons of rich parents, although they are generally eligible for such prizes as scholarships and exhibitions, do not possess the same advantage in competing for them. More, too, has been done in the universities than in the public schools to provide means by which the sons of rich parents may enjoy the distinction without the emolument of a scholarship. But it is an urgent matter that, alike in the colleges of the universities and in the public schools, the pecuniary benefits, by which alone deserving boys can rise above their hereditary surroundings, whether bursaries, exhibitions, or scholarships, should be strictly confined to the sons of the poor.

Here perhaps it is permissible, as it is certainly natural, to enter a protest against the established tyranny of examinations. Examination was once the obvious remedy for favouritism. But a mere examination in knowledge can never test some of the highest qualities which fit men and women for the service of the State. In India even more than in Great Britain the failure of examinations is conspicuous. A facility for answering questions upon paper is easily associated with grave defects of intellect and

character. In proportion, then, as favouritism ceases to be a public danger, examinations will, I think, lose something of their fatal authority. It is difficult to doubt that in the future candidates for public office will be required to pass a qualifying examination, but that the election will, at least in some degree, turn upon qualities which are not so easily tested by examination in writing.

Nor is this the whole evil. There is only too much danger that examinations may create a false ideal of educational success. The object of all education, as I have said, is to prepare pupils for the civic duties of mature life. It is not the intellectual attainment of the young at the age of thirteen or eighteen or even twenty-two, it is rather the service which they render to the State in the maturity of their powers, which is the proof of the teacher's influence upon their lives. The preparatory schools, which have become such important features in the field of secondary education, have done much useful work. The decadence of bullying and perhaps of other evils in public schools is largely due to the elimination of quite young boys from public-school life. The years of a boy's life from nine to twelve, but not, I think, to a later age, may well be reserved for the preparatory school, as the years from thirteen to eighteen for the public school. But the forcing process which is sometimes applied to young boys in preparatory schools, not only in their lessons but in their games, is fraught with serious peril. A preparatory-school master, if he thinks of his own school alone, may do even worse harm than a public-school master by sacrificing the future of his pupils to the present. When I was a headmaster, I knew of one preparatory-school master who tried to win boys to his school by offering what he called pre-preparatory scholarships to boys of eight or nine years of age, in the hope that these boys might after a time serve as advertisements for his preparatory school by winning scholarships from it at the public schools. But preparatory-school masters are not alone in fault. It is, I am afraid, easy to think of headmasters who have attained what I can only call an ill-deserved reputation, because their pupils have won numerous scholarships and exhibitions upon leaving school, when those same pupils had been mentally exhausted in youth, and their after-life in no way answered to the promise of their early days. "By their fruits ye shall know them"; but the fruits of a true education are seen not in the spring but in the summer or the autumn of a well-spent life.

It is with reference to the final goal of education that the subjects suited to the secondary curriculum must be judged. If the possible subjects are too many, it becomes necessary to strike the balance between utility and culture, and so to decide which subjects are indispensable and which may fairly be subordinated or postponed.

The most striking change which has come over secondary education has arisen from the number of subjects now claiming admission to the curriculum. Scarcely more than fifty years ago the headmaster of a public school was almost at his wits' end to fill up the time-table of his pupils. Dr. Arnold was appointed to the headmastership of Rugby in 1828, and Dean Stanley says of him that "he was the first Englishman who drew attention in our public schools to the historical, political, and philosophical value of philology of the ancient writers, as distinguished from the mere verbal criticism and elegant scholarship of the last century." He adds that, "besides the general impulse which he gave to miscellaneous reading both in the regular examinations and by encouraging the tastes of particular boys for geology and other like pursuits, he incorporated the study of modern history, modern languages, and mathematics into the work of the school, which attempt, as it was the first of its kind, so it was at one time the chief topic of blame and praise in his system of instruction." Other public-school masters followed suit, but they followed slowly. What the system of education had hitherto been may be judged from Malim's "Consuetudinarium," which specifies no subject of instruction except Latin, with a little Greek grammar in the sixth and seventh forms. The dancing-master was a more ancient and more honourable figure in some public schools than any mathematical master. Mathematics, in fact, were not introduced into Eton until 1836. Other subjects in addition to the classics came even later.

But within the last fifty years, not only mathematics but the English language and literature, foreign languages, natural science in its various branches, history and geography, have become competitors with the ancient classical languages for recognition in the curriculum of public schools. There is no one of them which is not worthy of such recognition. But the average intelligence of a public-school boy has remained the same, and the average length of his life in the public school has been diminished by as much as one-half. It has become necessary, therefore, to make a selection between the subjects which might well, if they could, be taught to all boys alike. Nor is this truth less applicable to girls than to boys.

It may be thought that not enough attention has been paid to the order in which particular subjects are taught. The number of subjects imposed upon a child of ten to twelve years is at times not less alarming than forbidding. Psychology suggests the adaptation of particular subjects to the awakening of particular powers at different ages. Even in literature there is a natural affinity which is too often disregarded between books and the ages at which they ought to be read. How many children have read "The Pilgrim's Progress" at too late, or have read "Hamlet" and "Paradise Lost" at too early, an age for true appreciation! In literature as elsewhere discrimination is the watchword of educational success.

From these considerations it seems to follow that the scientific educator must choose certain subjects as the basis of secondary education, and I venture to think that these subjects should be as nearly as possible common to boys and to girls. Other subjects can be left to the choice of particular students at a later period of their lives. Not all subjects are possible or useful to all students. Soon or late, then, uniformity of teaching must give way to specialisation.

Yet education loses a great part of its value unless it ensures to all educated men and women what may be described as a common educational property. It is desirable that they should not only all learn some things which are worth knowing, but that they should learn the same things. For upon community of information or of interest depends the sympathy of all educated people. If one person knows nothing but French, a second nothing but chemistry, and a third nothing but mathematics, it is evident that they possess no common stock of knowledge; no interchange of sentiments or ideas is possible between them. All sound secondary education, then, postulates a broad basis of common knowledge, or, in other words, a certain body of knowledge which is possessed by all students in common. Upon this basis must be built a superstructure varying in accordance with the needs or capacities of the pupils.

What, then, are to be the basal subjects of secondary education?

They must be few, they must be suitable to the tender years of school life, they must be practically useful, and yet they must possess the element of culture.

Religion, of course, will be one, for it is the paramount factor in the discipline of character.

The study of mathematics possesses the unique merit that it shows what proof is; it distinguishes certainty from probability; it evidences the narrow limits within which certainty is possible.

Natural science in its various branches is especially valuable as cultivating the faculty of observation. Scientific facts can be generally tested by experiment. It is only the pupil who has learnt at least the elements of natural science that begins to feel at home in the world in which he or she lives.

But among educational subjects the palm, I think, belongs to language, if only because language is the subject which stands, by its character as well as by its origin, in the most intimate relation to human nature. Men and women are not generally concerned with questions which can be absolutely and ultimately determined. Most questions in life are probable, but not certain; it is "probability," as Bishop Butler says, which is "the very guide of life"; and such, too, are generally linguistic questions. They do not admit of certainty; they can be decided only probably; and the decision of them requires tact, judg-

ment, and feeling. That is the reason why the school of languages is called Literae Humaniores at Oxford. Language is the one pre-eminently human or humane study.

But it is evident that different languages, as instruments of education, may stand on different grounds.

English boys and girls cannot afford to be ignorant of their own language or literature or history. For they use every day the English language; their minds are fed by English literature; and the past history of their country affords them guidance in the present and the future.

Foreign languages, on the other hand, are practically useful in the relation of Englishmen to other nations. It is possible that these languages will become less important as the English language spreads over the world. But for the present at least a knowledge of some modern language is desirable, not only as a means of mental discipline, but also as a means of intercommunication. One modern language at least, then, may fairly be regarded as entering into the basis of secondary education; and that language at the present time would naturally be French, although much is to be said for German and something for Spanish.

The educational difference between languages and other subjects is, I think, more clearly marked than the difference between one language and another. Whatever intellectual benefit is derivable from an ancient language may in a greater or less degree be derived from a modern language. But it has been shown by many writers, as, for instance, by J. S. Mill in his rectorial address at the University of St. Andrews, that a classical language, like ancient history, if only in virtue of its remoteness from present interests, possesses some educational advantage, and this advantage is particularly clear when an ancient language stands in the relation of Latin to the Romance languages or to any considerable number of languages in actual use. Latin must therefore enter into the general curriculum, and I attach great value to keeping Latin as a subject of general study in secondary schools. For the prejudice of parents in the present day against dead languages is unhappily strong. I have spent much of my time in trying to convince parents that their sons would be better educated by the study of Latin, if not of Greek also. It is for this reason that I regret the somewhat pedantic insistence upon pronunciation of Latin according to a method which, whether it be historically correct or not, will certainly tell against the universality of Latin as a subject of study. I do not believe the modern pronunciation is correct; but whatever may be the philological value of that pronunciation, I feel no doubt that the artificiality, as it seems to parents, of the non-English way of pronouncing Latin will, like the artificiality of the Greek type, create a prejudice in many minds against the study of Latin. Nor is this all; for the study of Latin loses a good deal of its practical value if every or nearly every Latin word is by the method of its pronunciation divorced from the corresponding word in English. It does not really matter in the present day how Latin is pronounced. Latin is no longer a medium of oral communication, even amongst scholars. The vital matter is that Latin should be one of the subjects constituting the permanent basis of education in all secondary schools.

Apart from these subjects, viz. religion, English, French, Latin, mathematics, and natural science, there is none, I think, which can justly claim a part in that knowledge which I have ventured to describe as the common property of all boys and girls in secondary schools. It is, in my judgment, a happy circumstance that preparatory-school masters have practically decided to relinquish the teaching of Greek, and to concentrate their efforts upon such subjects as form the natural basis of secondary education.

But upon the basis so constituted the teacher will try to erect a varying superstructure, by offering as wide a range as possible to individual tastes. For if the secret of education lies in discovering what a pupil's capacity is, and so in helping him or her to cultivate it, education must pass soon or late from the common basis of subjects to specialisation. It is not my business now to decide how the principle of specialisation should be applied. That is a problem which the individual schoolmaster or schoolmistress must work out for himself or herself. The two points upon which I would venture to insist are the common educational property and the wide elasticity allowable so soon as this common property has been gained. But I am of opinion that, while specialisation is allowable and desirable in the later years of a boy's or girl's life, it should never be complete. The dying out of double degrees in the Universities of Oxford and Cambridge has always seemed, and still seems, to me unfortunate. For it means that nobody now gets so thorough an education as was possible if the student applied himself through his life at school, as well as at the university, both to classical and mathematical studies. The amplification of the several studies may have justly affected the course of education in the universities; but it is my deliberate conviction that a boy or girl whose time is wholly or mainly given to one subject only during school life loses a signal opportunity of obtaining a generous education.

It is tempting to me as an old schoolmaster to linger on the field of secondary education. But the limit of time at the disposal even of the president of a section forbids me to think of adverting to more problems of secondary education than the two following:

Public opinion has always been divided in the education, whether of boys or of girls, between boarding schools and day schools. Adam Smith in his "Theory of Moral Sentiments" went so far as to say "that the education of boys at distant great schools, of young men at distant colleges, as well as ladies in distant nunneries and boarding schools, seems in the higher ranks of life to have hurt most essentially the domestic morals, and consequently the domestic happiness, both of France and of England." The complete severance of a boy or a girl, except during the holidays, from parents and family is evidently, or may evidently prove to be, an evil. It tends to undermine some of the graces of character; it produces in boarding schools the same defects, but perhaps, too, the same merits, as are observable in celibate religious institutions, like monasteries and nunneries. There is too much tendency, especially among parents of the wealthy class, to feel that they have done their duty to their children in paying their children's school fees, and to hand them over to the schoolmaster or the schoolmistress without any thought of the influence which the home ought to exercise upon young lives. It is reasonable to suppose that, if the sense of parental responsibility could be revived, fathers and mothers would be more anxious than they are now to keep their children at home in the early years of their lives. Preparatory day schools, at least in the great cities, will, I think, acquire a growing importance. But at present the choice between boarding schools and day schools for boys, and in a less degree for girls, is largely determined by pecuniary considerations. For in truth the great public boarding schools are such characteristic features of English life among the upper social class, they have gathered to themselves such a wealth of tradition and influence, they are so deeply rooted in the confidence and affection of the English-speaking world, that it would be difficult, if not impossible, to replace them. Nor can it be doubted that the education given in these schools, however rough and ready, however deficient in some respects it may have been, has yet done much, in Canning's bold ecclesiastical phrase, to produce "a supply of persons duly qualified to serve God both in Church and State," and has tended to foster some of the qualities by which the English race has attained its sovereign position in the world.

Again, there is the question of co-education. For if the early education of boys and girls may, as I have argued, safely proceed on the same lines, it may be held that they can well be educated together. Nor is there any valid educational reason why boys and girls should not be educated together, as they are in the United States of America. In England itself they receive their early education, and they are beginning to receive their academic education, together. It is at least conceivable that co-education throughout the period of school life may come to be the rule in day schools. In boarding schools, however, where the life is ordered on somewhat artificial principles, co-education would almost certainly create problems which

would enhance the difficulties of the master or mistress. I do not, therefore, anticipate that co-education in schools will assume a large importance in English life.

So far I have tried to indicate a few of the problems calling for the attention of persons who are engaged or interested in secondary education. Here at least I may claim to speak with some degree of experience. It is with hesitation that I approach the subject of the highest education as given in the universities, especially in the Universities of Oxford and Cambridge.

The elasticity which is characteristic of English life has in the last half-century created a number of local universities beside the two ancient universities. It would be unwise, even if it were feasible, to aim at assimilating the ancient and the modern universities. It is not impossible that the modern universities will lead the way in educational reform. The dead hand of the past lies heavily upon the historical seats of learning. No fact of educational history seems to be stranger than the inability, perhaps I ought to say the unwillingness, of the universities to reform themselves. It might have been anticipated that a home of learning would be a seat of powerful reforming energy. It has not proved to be so. The Universities of Oxford and Cambridge have been reformed more than once, but the reform has come from without and not from within. Whether the present Chancellor of the University of Oxford will succeed in persuading the university of which he is the distinguished head to reform itself without waiting for the action of Parliament is a question on which it would be unsafe for me to venture an opinion. But his plea for reform is itself a proof that reform is needed. It will not, however, be unfitting that I should insist upon the value, and the ever-increasing value as I think, of the work belonging to the modern universities in the great cities of the land—can I be wrong in saying pre-eminently to the Victoria University of Manchester? History seems to suggest that the association of a seat of learning with a great centre of industry may produce the best results, in so far as it imparts culture to industry and practicality to learning. The modern universities have appealed with striking success to the generous instincts of local patriotism. They have shown the possibility of gathering an earnest body of teachers, and through them of imparting a genuine intellectual culture to a large number of students, without imposing artificial restrictions upon their studies. They have proved the possibility of uniting men and women upon equal terms in the same academic institutions. The Victoria University has aimed with conspicuous success at solving the difficult problem of uniting the teachers who belong to the different branches of the Church in a common faculty of theological learning. In some of these respects, if not in all, the Universities of Oxford and Cambridge will probably follow suit. It can scarcely be doubted that the time is not distant when Oxford and Cambridge will open their doors to students without insisting upon the so-called compulsory study of the Greek language. I speak as one who more than a quarter of a century ago argued against the policy of requiring some knowledge of two dead languages from all students as a condition of entrance into the ancient universities. Such a requirement may have been possible, and even reasonable, when educational subjects were few. It cannot be maintained when those subjects have been greatly multiplied. For the result is either that the study of two dead languages, or at least of one among them, is little more than a farce, or that it causes an unhappy disturbance at a critical period of a boy's intellectual life. Nay, I should be tempted to say that to boys who have received their education on the modern sides of public schools the obligation of acquiring some smattering of Greek knowledge is both a farce and a nuisance.

Nobody feels more keenly than I the intellectual benefit of studying the Greek language and literature. It is my sincere hope, as it is my firm belief, that, when Greek rests upon its own intrinsic merits as a factor in human culture, the study of Greek, if it is less general, will not be less profound than it has been. But times change, and compulsory Greek as a universal subject is unsuitable to the present time, not because it is useless in itself, but because it bars the way more or less against other studies which are still more important. The universities enforce their law upon secondary schools. The schools must teach what the universities require; they cannot teach, or they can only teach within a fixed limit, what is not required at the universities.

In my own mind, however, the abolition of compulsory Greek is only a step to a change in the intellectual atmosphere of the universities. I hope that Oxford and Cambridge will cease to insist upon Greek; but I hope that, when they cease to insist upon Greek, they will require from all students the evidence of some serious learning in some subject or subjects of higher education. Nobody who is conversant both with the ancient and with the modern universities can fail to be aware of the difference in their tone. The atmosphere of a modern university is intellectual. Men and women come there as students: they come to learn, and they do learn. At Oxford and Cambridge the atmosphere is much more social; and the number of undergraduates who can in any sense be called serious students is but a fraction of the undergraduate body. The time is, I hope, approaching when a degree conferred by the Universities of Oxford and Cambridge even upon a passman will be a certificate of a certain definite proficiency in some recognised subject of academic study. For it seems to me that the ancient universities in conferring degrees without an adequate guarantee of knowledge are largely responsible for the indifference of English society as a whole to the value and dignity of learning.

No doubt there is force in the plea that the universities cannot afford the pecuniary loss which would result from the policy of excluding passmen, or of pressing hardly upon them. It may be answered that no pecuniary consideration can justify a university in ceasing to be primarily a learned body. But women students are more earnest than men; and if the universities grant degrees, as I hope they will, to women equally with men, they will probably find that they will receive as much money from the addition of the serious students, who will then belong to them, as they now receive from those students who are not serious at all.

The Universities of Oxford and Cambridge have made frequent appeals for pecuniary support. Education—especially scientific education—is expensive, and it tends to increase in expensiveness. But I have sometimes wished that, before money is poured into the exchequers of the universities, a commission, composed of men who are fully sympathetic with academic culture and yet have been trained in the habits of business, could issue a report upon the use now made by the universities and by the colleges of the funds which they severally command. I am of opinion that such a commission would not prove unable to suggest the possibility of large economies which might be carried out without impairing the efficiency of the universities as seats of learning, or even of the colleges as homes for the students whose proper object in their academic life is to acquire learning.

All that remains is to offer an opinion in some few brief words upon some subordinate matters of academic education.

There is something to be said in favour of, but more perhaps to be said against, the proposal for two concurrent kinds of degrees, the degrees of Bachelor and Master in Arts and of Bachelor and Master in Science. For the academic degree possesses a recognised advantage as setting one and the same hall-mark upon all persons who possess it. It would be less distinctive, and therefore less valuable, if its significance were not uniform. Nor does there seem to be any valid reason against conferring the degree of B.A. and M.A. upon all students who have shown themselves to possess a certain uniform culture, whatever special study or studies they may have pursued and whatever degree of excellence they may there have attained, after satisfying the requirement of culture demanded from all persons who aspire to the possession of an academic degree.

Again, it is desirable that every university should be free from theological restrictions. I look forward, therefore, to the time when the Universities of Oxford and Cambridge will recognise Nonconformists no less than Churchmen as eligible, not only for degrees, but for lectureships and professorships in the technological faculty. There is a broad distinction between the study of theology and the profession of theological beliefs. It is no hardship upon a student that he should be examined in theology so

long as he retains his complete freedom of theological opinion. That theological recognition should be accorded to none but persons of particular views upon theology is in conflict with the highest interests of theological learning. At present the Universities of Oxford and Cambridge are the close preserves of the Church of England; the natural result is that the modern universities tend to become the preserves of Nonconformity, and neither class of university is benefited by the consequent one-sidedness of theological study.

The co-education of men and women in the universities, whether ancient or modern, is already an established reality. The only difference is that co-education is recognised in the modern, and is not recognised in the ancient, universities as necessarily leading to an equality in the matter of degrees. The real objection to placing women on an equality with men in their relation to a residential university is the difficulty of finding room for a number of female as well as male students within the precincts of the same university. On that ground alone there is some advantage in universities or colleges for women only, such as the Royal Holloway College; but experience has shown that colleges for women do not flourish except in close relation to a university in which the education of men is carried on, and I feel no doubt that the granting of academic degrees at Oxford and Cambridge to women as well as to men is merely a question of time.

No critic of the ancient universities, and certainly no one who has spent some happy years there as an undergraduate and a Fellow, can forget that the social as well as the intellectual side of the life is a part of its privilege and benefit. But that social intercourse would lose something of its value if students of different classes and different creeds did not mix freely. It is too often forgotten, in the zeal for ecclesiastical propaganda, that one element of education lies in teaching people who do not agree to work together. To make the least, and not the most, of personal differences is a factor in the life of universities. It is for this reason that I do not look with any great favour upon the institution of special colleges set apart for Churchmen or for Nonconformists or for men of poor and humble circumstances. It is better that such students should, as far as possible, associate with other students; for in such proportion as undergraduates of religious feeling or of strenuous self-denying character are educated by themselves, there is a diminution of their valuable influence on the mass of the undergraduate body. There might as well be Conservative Colleges and Liberal Colleges as colleges of a special and exclusive theological character.

Colleges are expensive features of academic life, and they tend to become more expensive; but the expense is justified by the benefit which the students may receive from the influence of their teachers upon their lives. But if colleges are to exist as integral parts of the university, there should be a sufficient number of Fellows and tutors living within their walls. No feature of modern life at Oxford or Cambridge is more pitiable than the spectacle of a married don coming into his college at a late hour of the evening, with his carpet-bag in his hand, to fulfil the statutory obligation of sleeping within the walls. No deep personal interest or influence of a tutor in the lives of his pupils is possible in such circumstances as these. If only it were possible to defer the opportunity of marriage until a man has rendered some years of service by residence within the walls of his college, and then to grant it only to men whose service the college wishes to retain, the collegiate life of the ancient universities would be less likely to lose its effective value.

But when all is said, how great is the charm of the ancient English universities! They are unique; they exercise a lifelong spell upon pupils who have spent three or four years within their ancient walls; they foster, even if unconsciously, a noble sense of patriotic duty; they haunt the memory; they are fruitful in high and generous and sacred inspirations.

What is the spirit of a university? How is it born? How does it operate? Why is Cambridge in a special sense the home of mathematics, and Oxford of letters? Why is it that Oxford finds so many, and Cambridge so few, representatives upon the public Press? Cambridge, it seems, has played the greater part in the thought, and Oxford in the life, of the nation. But why is it that Cambridge has given to the world sons more famous, it may be, than any whose names belong to the sister university—Bacon, Newton, Cromwell, Milton, and Darwin? Why, above all, is Cambridge in so pre-eminent a degree the university of the poets? Such names as Milton, Ben Jonson, Herrick, Cowley, Byron, Gray, Wordsworth, Tennyson, belong to Cambridge alone. Nothing can replace, nothing perhaps can greatly affect, the relation of the ancient universities to the country the ornaments of which they are. What is needed, and will be more and more needed as democracy extends its power, is to enhance the strength of the influence which the universities exercise upon the national life at large.

So I bring this imperfect review of the educational problem in its present aspects to a close by insisting in two or three final sentences upon the supreme dignity of the teacher's profession. The man or woman who elects to become a teacher chooses a great responsibility. It is well that teachers should be disciplined for their calling by a system of training in the educational art. The theory of education as set forth in the writings of great educators like Comenius, Froebel, Pestalozzi, Arnold, Thring, Fitch, and many others, should be well known to them, even if the practical side of education is best learnt, or can only be learnt, by practice. Education needs the best men and the best women. It must, therefore, be set free from such bonds as have tied it to the clerical profession; nor can I think it is ever well to exact religious tests of teachers, for tests are apt to affect tender consciences alone. If only teachers are asked whether they wish to give definite religious instruction or not, and are subjected to no drawback or disadvantage if they choose not to give it, I think the teachers in all grades of schools may be trusted not to abuse their sacred opportunity. They must teach their pupils to love learning and virtue, and to love them for their own sakes. They must remember that it is the personality of the teacher which is the chief source of his or her influence on the pupils. They must ever be trying to make themselves more and more worthy of their responsibility. "Thou that teachest another, teachest thou not thyself?" must be the motto of their daily lives. But where the educational profession is one in all its branches, where it is actuated by a due sense of responsibility, where it aims in season and out of season at cultivating habits of self-respect, self-sacrifice, patriotism, and religion in the children who will be the citizens of the future, where it remembers that the supreme triumphs of educational skill are good men and women, good fathers and mothers, good servants of the State and of the Church, there is no ground of fear for the country or the Empire.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE meetings of the Chemistry Section were of unusual interest and briskness, all the speakers copying the example of clearness combined with brevity so admirably set by Prof. Walker in his presidential address. The section had organised its programme carefully beforehand and the arrangements made were strictly adhered to: as was to be expected, the subjects discussed were largely of a physical chemical character. A feature of the attendance was the presence of a number of members from the Physical and other sections; it was evident that papers of a type likely to bring sections together and to provoke discussion between the sections are those most required at the sectional meetings of the association.

There still remains much to be done by those responsible for the organisation of the Association in the way of preventing overlapping; it was noticeable, for example, that several chemical papers were read in other sections which should properly have been brought before Section B. It seems a pity also for a section which is taking part in a joint discussion to arrange for a separate meeting of the section at the same time, as this procedure affords specialists an excuse for avoiding the joint meeting. They thus neglect the opportunity of realising how differently in many cases the same facts are interpreted by followers of another branch of science.

The sectional meeting room was at first situated in Fawcett Road, a considerable distance from the other sections; this position was found to be so inconvenient that a move was made to the Municipal College. It would appear important that Sections A, B, and G be housed in close proximity, so as to facilitate exchange of views between members of these sections. The section was supported by several foreign chemists of distinction.

The proceedings were opened with Prof. J. Walker's address, following which Prof. Carl Barus, of Providence University, U.S.A., read a paper on the diffusion of gases through water in which a novel and simple experimental method was described. The method consists in finding the temperature-pressure conditions for the flotation at a given level of a cylindrical cartesian diver, in which the gas to be examined has been imprisoned. Slides were exhibited showing the details of the apparatus and the mass-time graphs for the interdiffusion of gases through water. Whereas the graphs for a single gas are linear, those for pairs of gases are of indefinite variety, and the very curious result of a gas apparently diffusing against the pressure gradient is frequently met with. Such anomalous results are explained in terms of the partial pressures of the constituents of the imprisoned impure gas.

Dr. W. C. McC. Lewis dealt with the compressibility of mercury. He regards the usually accepted value as incorrect, since for mercury the difference between the latent heat of vaporisation as determined and calculated from a formula involving the compressibility is large. Dr. Lewis suggests as possible sources of error in the experimental determination :—

(1) Effects produced by a layer of absorbed air or moisture, or both, between the mercury and the walls of the vessel;

(2) That the liquid (molasses mixture) into which the piston was dipped before insertion in the mercury is not completely removed; and

(3) The unavoidable slip of the mercury past the piston.

All these effects act in the same direction; *i.e.* they give rise to too great a volume decrease, that is, to too high values of the compressibility.

Dr. J. F. Thorpe followed with a somewhat technical paper on the chemistry of the glutaconic acids, in which he quoted experimental evidence to show that the molecule of glutaconic acid must have a symmetrical structure, and that the cause of the identity of the α and γ positions must be of the same order as that determining the equality of the meta positions in the benzene ring. Some interesting conclusions based on the experimental study of the properties of the alkylglutaconic acids were also described.

In a discussion, Dr. Lowry differed from the author's interpretation of his experiments.

Mr. G. Le Bas gave a summary of an elaborate paper on the effect of constitutive influences on the molecular volumes of organic compounds at the boiling point; the subject is too complex to allow of a brief abstract.

The last paper, by Prof. R. Wegscheider, dealt with the influence of substituents on reaction velocities. The elucidation of the laws governing the transformation of organic compounds is to be found in the study of reaction velocities. Prof. Wegscheider has chosen for this purpose the esterification of asymmetric dibasic acids and the saponification of their esters. He finds there are at least two different properties of the substituting groups which act to determine their influence on reaction velocities. One of these is the influence on the electrolytic dissociation; the other is termed steric hindrance, though it is a function of several single properties. Laws for the esterification of dibasic carboxylic acids were based on these considerations and their behaviour in actual practice exemplified; though on the whole satisfactory, there are numerous exceptions, but this was to be expected, as the assumption, that one property only of the substituent influenced the reaction velocity, can only be a rough approximation.

A report on the present position of electric steel making was presented by Prof. A. McWilliam. This is in type, and can be obtained at the British Association offices. The report shows the progress in the electric steel melting industry made during the year, whilst the actual state of the industry can be judged from two tables, in which are shown the furnaces, capacities, and kind of work done by the firms of Kjellin, Röchling-Rodenhauser, and Héroult. In this country we have Héroult's furnaces of a united size of 25 tons. A list is given of the applications of the electric furnace. The report is mainly a statement of industrial advance, and is somewhat disappointing from the point of view of the chemist.

The commitee appointed at the Sheffield meeting with a grant to study the influence of carbon and other elements on the corrosion of steel, reports on the behaviour of a series of six pure iron-carbon alloys prepared by the coke crucible process at Sheffield University. Carbon exerts two types of influence on the corrodibility dependent upon the condition of the carbide in the steel. In the rolled and annealed specimens the corrodibility rises to a maximum at the saturation point (0·89 per cent. of carbon), and then decreases upon the appearance of cementite in the steel. In the hardened and tempered specimens the corrodibility rises continuously from 0·1 per cent. to 0·96 per cent. of carbon, no maximum being observed at the saturation point. It is considered that the finer the state of division of the carbide in the pearlite the greater the liability to corrosion when immersed in sea water.

The treatment previously undergone by the steel also influences the solubility in acid solution. Curves are given for steels treated in different ways, showing the effect of increasing proportions of carbon. It is established that the resistance offered by carbon steels when immersed in solutions varies considerably, acording as to whether the solution is of the sea-water type or is acid in character. Each case must therefore be considered separately, and it is impossible to specify any particular composition or treatment offering the best resistance to attack under all conditions.

Friday, September 1, was devoted to papers on indicators and colour. Mr. Tizard's paper on the sensitiveness of indicators will be published in full, and copies will be available at the offices of the British Association. His main conclusions are as follows :—An indicator is now regarded as a pseudo-acid or base : the undissociated molecule consists of two, or more than two, tautomeric forms in equilibrium. This conception does not affect Ostwald's method of treatment, provided that the tautomeric changes that may take place are practically instantaneous. From a physico-chemical point of view the ions may still be regarded as differently coloured from the "undissociated molecule," if it be understood by this expression not one particular molecular species, but the equilibrium mixture of the various forms which the indicator can assume in its undissociated form. Applying Ostwald's dilution law to the special case of indicators, it is easy to show that when the colour of an indicator in solution is exactly midway between the extreme colours of its dissociated and undissociated forms, then the concentration of hydrogen ions (C_H) in the solution must be numerically equal to the dissociation constant of the indicator. Further, if this be denoted by Ka, the colour change takes place mainly between concentrations of hydrogen ions of $10Ka$ and $\frac{1}{10}Ka$. It follows that the most useful indicators are those which have dissociation constants not very far removed from 10^{-7} (the concentration of hydrogen ions at the true "neutral point"), between 10^{-5} and 10^{-9}, for example. An indicator which is a very weak acid or base is of no more value than one which is very strong. It is of importance to know the dissociation constants of indicators accurately.

If the range of sensitiveness of an indicator is known, it is possible to deduce the "end-point" of an indicator; that is to say, the probable concentration of hydrogen (hydroxyl) ions in a titrating solution at the point where titration is usually stopped. The end points of indicators can also be found by direct experiment; as a rule it is, of course, only possible to stop a titration *between* certain concentrations of hydrogen ions, the extent of the range depending on a number of factors.

The accuracy of a titration of any acid by any base depends very largely on the proper choice of an indicator. This may be seen most clearly by drawing curves showing the concentration of hydrogen ions in a solution of a salt when small quantities of acid or base are added in excess. From such curves it can be deduced that an indicator which has a sharp end point in any particular volumetric opera-

tion gives an accurate result to within about two parts in a thousand.

Dr. Lowry gave a valuable paper on the origin of general and specific absorption, virtually an extension of the report of the Commitee on Dynamic Isomerism, which is doing work of extreme value in this difficult field. During the past year attention has been directed to the study of general absorption, and attempts have been made to determine the approximate positions of the inaccessible bands to which this type of absorption curve appears to be due. The method adopted depends on the fact that most of the optical constants of a substance increase with great rapidity when an absorption band is approached, and appear to tend towards an infinite value in the case of a sharply defined absorption-line. With carbon compounds the magnetic rotatory dispersion has been found a convenient property to discuss, and the measurements have been used to calculate the position of the heads of the inaccessible bands by which the general absorption is produced.

The chief conclusions drawn are that the optical properties of most saturated carbon compounds are determined by an absorption in the far ultra-violet. The dominant absorption is brought nearer to the visible region by introducing an ethnoid linkage, as in allyl alcohol, or a benzenoid nucleus, as in phenylethylcarbinol, but in none of the simple compounds investigated does it fall within the region usually photographed in the study of absorption spectra.

Mr. J. E. Purvis described the ultra-violet absorption spectra of the vapours of organic substances, as compared with their absorption in solution and in thin films, and discussed the results from a consideration of the movements of the atoms of the molecules being influenced by their nature, weight, type, and orientation. The vapour molecules have a greater freedom of movement and a considerable number of bands are produced. In solution the solvent acts partly as a constraint on the vibrations, partly as a barrier to the number of encounters, and partly as an absorbent of the radiant energy, so that the narrow absorption bands of the vapours are usually replaced by wide diffuse bands. In thin films the movements of the molecules are further restricted; the selective absorption is not unlike that in solutions, but the bands are shifted more towards the less refrangible regions.

Dr. P. V. Bevan introduced the subject of absorption and dispersion in metallic vapours. Following the work done by R. W. Wood in the case of sodium, he has measured the characteristic lines of other alkali metals. These all appear as absorption lines when white light is passed through the vapours of the metals; with increase of density of the metal more lines come into view. They form a series, getting closer together at the ultra-violet end of the spectrum. The bearing of the phenomena of dispersion in metallic vapours on the optical theory was discussed, particularly the views as to the nature of the atom and the vibrating systems that give rise to spectrum lines. Each line of the series is probably due to a special set of atoms, and there are indications that the complexity of a spectrum is not due to complexity of each individual atom, but to differences actually existent in the atom. There is a good deal of evidence leading in the same direction.

Rubidium and cæsium vapours are obtained practically pure by heating the chlorides with lithium, owing to the much greater temperature required for vaporising lithium than for the other metals.

The concluding paper read by Prof. Pope summarised work done jointly with Prof. W. H. Perkin on optically active substances which contain no asymmetric atom in the molecule. The demonstration of the somewhat involved conceptions employed was rendered intelligible by the use of models. The authors have synthesised 1-methyl*cyclo*hexylidene-4-acetic acid and resolved it into optically active components by means of brucine. It is proposed to distinguish this type of asymmetry as "centroasymmetry." The action of bromine and other substances on these acids was described; it is remarkable that no evidence of any optical inversion was obtained. It is noteworthy, further, that the long series of changes to which the centroasymmetric acids were subjected yielded products, which did or did not show optical activity precisely in accordance with anticipations based on the study of the solid models representing the substances concerned. This is an important demonstration of the fidelity with which constitutional formulæ depict molecular configuration, and should not be overlooked by physicists.

Prof. H. Euler, of Stockholm, opened the proceedings on the Monday with a brief paper on the velocity of formation of enzyme systems. The results described, though of a preliminary character, were significant as showing how the amount of a particular enzyme in an organism can be caused to increase by cultivating the organism for several generations under suitable conditions. Experiments on the formation of invertase and of enzymes fermenting glucose and galactose were described. Prof. Euler had been unable to train certain yeasts to acquire the power to ferment galactose. In discussing the paper, Dr. E. F. Armstrong expressed the belief that there was an essential difference between the power to acquire an entirely new enzyme and that of regaining an enzyme, which had not been required by the yeast for many generations, and so had fallen into disuse. The former was impossible, whereas many brewery yeasts were able to regain, as the result of training, the lost property of fermenting galactose.

In opening a discussion on the part played by enzymes in the economy of plants and animals at a joint meeting of the Chemical and Agricultural Sections, Dr. E. Frankland Armstrong gave a definition of enzymes, pointing out their connection with practically all processes of metabolism in living organisms, and emphasising their specific nature. One function of enzymes is to break down complexes in the cell; there is a necessity for some restriction of action; otherwise the cell would soon be killed. The safeguards of nature to prevent this were described. It was shown how the leaves of the cherry laurel, which give off hydrogen cyanide, or those of the Japanese laurel, which blacken, can be used to indicate that changes are taking place in the plant cell. The resting leaf can be stimulated into activity by a number of substances, of which toluene and chloroform are examples, which as a class are characterised by being chemically inert substances, and further by having but little affinity for water. It is suggested that such substances, to which the general name hormone is applied, are able to penetrate the cell and bring about hydrolytic changes within it. A large number of substances which act as very weak hormones are found in plants combined with glucose, as the so-called glucosides. It is believed that one function of glucosides is to act as hormones when a specific mild stimulus is required by the plant. Each glucoside requires an appropriate enzyme to hydrolyse it before its constituents can be effective as hormones. The speaker alluded to the wide distribution of glucosides in plants, and gave an account of work done in localising and studying their appropriate enzymes. Whereas the leaves of a plant contain, as a rule, an enzyme adapted only for the glucoside contained in them, the seeds of the same plant contain an enzyme or mixture of enzymes able to attack a variety of glucosides. The practical application of these researches to a number of problems in animal and vegetable physiology and agriculture was illustrated in detail. The discussion was general, and mainly turned on controversial points.

The rest of the morning was devoted to a paper by Mr. A. E. Humphries entitled "Some Points concerning the Treatment of Wheaten Flour." This contained one new point of very considerable importance. It has been found that the addition of very small amounts of salts, natural to flour or to the ash of wheat, increases the size of the loaf, though it has no effect on the production of gas in fermentation. In one instance the mere addition of water to flour, so long as it was made at a time substantially prior to dough-making, increased the strength of the flour to an extraordinary extent. Investigation showed that, following the addition of water, there was actual change of the organic phosphorus compounds of the flour into inorganic, and that further a still larger proportion of the organic phosphorus compounds are transformed during bread-making. The change is probably enzymic in character.

In conclusion, Mr. Humphries alluded to the difficulties millers have to face, and claimed that they should be allowed to make use of the advances in chemical knowledge in the treatment of wheats and flours.

Tuesday, September 5, was reserved for papers on colloids. A very admirable and fluent introduction on the

general theory of colloids was given by Dr. H. Freundlich, of Leipzig. Colloidal solutions stand between the two extremes of true solutions and coarse suspension, such as formed by very sparingly soluble substances which do not react with the solvent. Colloidal metals, sulphides and hydroxides are termed "suspension" colloids or lyophobic sols; organic colloids, which approach more nearly to the true solutions, are lyophilic sols, or "emulsion" colloids. In the coagulation of suspension colloids the electric charge is of importance, and the addition of an electrolyte, by discharging the particles, facilitates coagulation. In the case of emulsion colloids, the individual characters of the substances concerned are the determining factors, electrical conditions being of far less importance. An account was given of the phenomena of adsorption, which the author is inclined to regard as an effect of surface condensation. Finally attention was directed to the bearing of colloid chemistry in a number of directions. A very full discussion followed, in which Sir Wm. Ramsay, Prof. Martin, Prof. Trouton, and others took part.

The ensuing paper by Dr. Barger dealt specially with some applications of colloidal chemistry and its theories to pharmacology. In a second paper Dr. Barger gave an account of the adsorption of iodine by the glucoside saponarin, which, on account of its being a pure substance of definite composition and molecular weight, affords a more favourable instance than starch for the study of the iodine colouration.

The colloid theory of cements was the subject of a very lucid paper by Dr. C. H. Desch. The explanation of the setting of calcareous cements, as caused by the crystallisation of the products of hydrolysis from a supersaturated solution, fails to account for the great mechanical strength of such cements. The colloid hypothesis proposed by Michaelis attributes the setting to the formation of a gel of calcium silicate, which subsequently hardens by loss of water and adsorption of lime. Microscopical examination confirms Michaelis's view. The only constituent of the cement which is acted on is the alite. The hydrolysis of the complex substances contained in the alite first sets free calcium aluminate, which separates in the form of crystals. This constitutes the initial set. The calcium silicate is more slowly hydrolysed, and the calcium monosilicate produced, being extremely insoluble, separates as a colloidal gel. A part of the calcium hydroxide liberated crystallises in large plates, and is readily detected by the microscope, whilst another part is adsorbed by the silicate gel. The gradual increase of strength which is characteristic of calcareous cements is a consequence of the continued adsorption, and of the physical changes in the structure of the gel.

The colloids formed may be examined and characterised by staining with dyes, such as methylene blue, patent blue, and safranin. The principal difficulty in the microscopical examination of cements has hitherto been the brittleness of the material, making it impossible to grind very thin sections, resulting in loss of clearness. This may be avoided by treating the cement as a metallographic specimen, grinding and polishing one surface only, and examining under vertical illumination after etching with weak acids or staining with other reagents.

A brief paper on the rate of coagulation of colloidal copper, by Mr. H. H. Paine, described the preparation of the solutions and their coagulation by simple salts; there is an initial period during which the solution remains clear. The rate of precipitation is proportional to the square of the initial concentration of the colloid; for varying amounts of the electrolyte the rate of coagulation is proportional to some power of the concentration of the salt.

Reports were presented by all the sectional committees, and a new committee was appointed by the section for the study of plant enzymes, with Mr. A. D. Hall as chairman and Dr. E. F. Armstrong as secretary. Dr. Orton reported on the transformation of chloro- and bromo-amines into halogen anilides, on the velocity of chlorination of anilides, and on the formation of nitroamines. The attention of the Electroanalysis Committee has been directed during the past year particularly to the application of the electrometric method to the titration of weak acids in such liquids as tan liquors.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE proceedings of Section C (Geology) were not marked by any epoch-making paper, but a number of subjects of geological interest were dealt with. On Thursday (August 31) the section opened with the address of the president (Mr. A. Harker, F.R.S.), which was a scholarly and stimulating treatment of some aspects of modern petrology, in which the arguments of his treatise on "The Natural History of Igneous Rocks" were followed to further conclusions on the conditions of their distribution and genesis.

Of those who did yeoman service to the section, Mr. Clement Reid, F.R.S., came easily first, his intimate knowledge of the locality being freely drawn upon at two meetings, and a third being made notable by a masterly paper on the relations of the Glacial period to the plant population of the British Isles.

Following the president's address came Mr. Reid's paper on the local geology. Portsmouth, he pointed out, was the centre of geological features of considerable interest, in which the student was brought face to face with many difficult problems. The geological map showed bands of colour ranging east and west, which in a flat country indicated inclined strata having a well-marked strike, and Portsmouth was near the central axis of the Hampshire Basin. It was also close to one of the subsidiary ripples on the great earth-wave, which formed Portsdown Hill. The Hampshire Basin was a great synclinal fold, and the planing of this fold by river and sea rendered visible 6000 feet of strata within short distance of Portsmouth. The oldest rocks seen on the surface were the Wealden and Lower Cretaceous beds of the Isle of Wight. The Chalk which forms all the higher hills may be taken as a foundation, as it is the oldest formation which plays any obvious part in the geology of Portsmouth. The upper zones had been carved away before the deposition of the Lower Tertiaries, and much of the Lower Eocene was also missing. The lowest brackish-water clays have yielded no fossils near Portsmouth, but the London Clay includes an irregular, siliceous bed (Bognor Rock) which is very fossiliferous. Succeeding these come the Lower Bagshot beds, which are poorly displayed near Portsmouth, but thicken out at Alum Bay into a mass of current-bedded sands in which occur beds of lignite and lenticles of pipe-clay containing leaves of tropical plants. These sands pass up imperceptibly into the marine Bracklesham beds, which contain many drifted plants, and include a prolific marine fauna of tropical appearance. Following in regular succession comes the deeper water Barton Clay with its great variety of beautifully preserved Mollusca, followed by the Barton Sands, at the top of which it has been the custom in England to draw the line between the Eocene and Oligocene formations, because the succeeding strata are markedly different in character, and the junction is rendered conspicuous by an underclay and a swampy land-surface; but the line of demarcation is now drawn higher up to suit the general European classification. The Fluvio-marine series of the Isle of Wight and the New Forest form a well-marked natural group of strata consisting in the main of mottled clays and silts of lagoon and brackish-water origin, with subordinate bands of white tufaceous limestone and marl. Bands of marine origin are quite subordinate except at the top. The occurrence of scattered angular chalk flints at various levels seems to point to the proximity of dry land against which the strata abutted. The Fluvio-marine series carries the succession up to the Middle Oligocene. All the higher Tertiary strata have been destroyed, and the next deposit is of Pleistocene date.

The remarkable folds which have affected all the strata of the Hampshire Basin, from the evidence of the Portsmouth district, are in the main newer than the Middle Oligocene. But evidence obtained lately in Devon seems to show that the folding was of Upper Oligocene or of Lower Miocene date. That is to say, these disturbances date from the same period which saw so much folding, disturbance, and mountain-building throughout Europe, and originated the chief Tertiary basins. The Miocene and Pliocene periods have left no legible traces in this neighbourhood, and all we can say is that during these

periods were initiated the curious courses of the rivers of the district. The intricate channels and harbours of the Hampshire coast are the product of this long denudation combined with oscillations of land-level. The Hampshire and Sussex coasts yield particularly clear evidence of the curious alternations of climate which characterised the Pleistocene period. The ice-sheet did not extend so far south, but there is abundant evidence of two cold periods separated by a milder stage. Man must have seen many of the later of these changes. He certainly hunted the reindeer on Salisbury Plain, and probably hunted the seal and walrus amid the pack-ice of the Portsmouth coast.

Prof. S. H. Reynolds gave a description of further work on the Silurian rocks of the Eastern Mendips, in which the results of opening a series of fresh trenches were detailed. The fossils obtained showed that the sandy mudstones to the south-east of the Moon's Hill Quarry are of Wenlock rather than of Llandovery age. The strike of these Wenlock rocks is completely discordant with that of the underlying Old Red Sandstone, and precludes the possibility of a conformable passage from Silurian to Old Red Sandstone. No trace has been found of a Ludlow fauna. The dip of the Wenlock rocks is such that they clearly overlie the andesite of Moon's Hill.

Dr. A. R. Dwerryhouse outlined his recent investigations on the glaciation of the north-east of Ireland. He concluded that the area including the Antrim basaltic plateau, the Silurian uplands of County Down, and the Mourne Mountains had been completely overriden by the Firth of Clyde glacier, during the retreat of which the drainage of the district was impounded and a number of lakes formed. The overflow channels of these lakes have left "dry gaps," which mark the various stages in the shrinkage of the ice, the earliest of which appear on the flanks of the Mourne Mountains at an elevation of 1200 feet. Many interesting examples of the diversion of rivers by morainic material occur, and the changes in the history of the Lough Neagh area were outlined. It has been stated that the Antrim plateau was glaciated by local ice after the retreat of the Firth of Clyde glacier; but Dr. Dwerryhouse had failed to find any direct evidence of this, though the valleys of the Sperrin Mountains to the west were occupied by local glaciers.

The Glacial period and climatic changes in north-east Africa was the subject of a paper by Dr. W. F. Hume and Mr. J. I. Craig. They predicted a southerly shift in the system of westerly moist winds of the northern hemisphere due to the ice-cap by several degrees, with a decrease in temperature below the normal. These winds, which now barely touch the north coast of Egypt in winter, would then impinge upon the loftiest portions of the Red Sea mountain range. Evidence of this increased rainfall is found in the gravel terraces on their western slopes, the materials of which could only have come from the hills to the north-east. The precipitation was most active where the range was highest. Further evidences of such a westerly current are to be found in the existence of calcareous tufas on the borders of the eastern scarp of Kharga Oasis and elsewhere. The authors also found evidence of changes in the monsoon effects during the Glacial period. It is known from the investigations of the Meteorological Department of India that an increased snowfall in the Himalayas in spring exercises a measurable prejudicial effect on the Indian monsoon of the present day, and the enormously greater ice-covering of the Glacial period would exercise a more powerful inhibition on the monsoon of that period. The more extensive ice-sheet of East Africa, by preventing the abnormal heating of the land in summer, would act further in the same direction, and it is extremely probable that the monsoon current partook of the southerly displacement. The general result would be a decreased precipitation over Abyssinia and a much reduced Sobat, Blue Nile, and Atbara, which at the present account for 96 per cent. of the flood proper of the Nile. The study of the alluvial muds of the Lower Nile indicates a much smaller rainfall in Abyssinia about 14,000 years ago, previous to which the mud-laden waters of the Abyssinian Nile system do not seem to have reached Egypt. Mr. Grabham confirmed this conclusion by evidence from the Sudan of an earlier, moister climate further south than now is the case.

Friday, September 1, was devoted to a joint meeting with Section E (Geography), which was opened by a discussion on the former connection of the Isle of Wight with the mainland, the subject being introduced by Mr. Clement Reid, F.R.S. Mr. Reid pointed out that the Solent and Spithead occupy parts of a wide river-valley in which terraces of gravel slope up to 400 feet, though in the centre of the valley they pass actually beneath the present sea-level. These gravels have a very peculiar composition, and the higher terraces are full of Greensand chert, and contain fragments of Palæozoic rocks belonging originally to the West Country. The old idea that these cherts came from the central area of the Weald has been found to be untenable, and it has now been found possible to trace these stones to their origin, and so unfold a beautiful example of river development and river destruction. When first earth-movements formed the Tertiary basins of Hants and London, each of these basins was closed by harder rocks to the west, and was occupied by an eastward-flowing river, the Thames and the Solent. The valley of the Thames seems merely to have deepened, retaining all along approximately its original course. The valley of the Solent, on the other hand, ran for some distance parallel to the sea, and at no great distance from it, the result of which was that the sea finally broke through the narrower ridge of chalk which once ran continuously from the Needles to the Dorset coast, thus diverting the Frome and all the western rivers from their natural course to the Solent, and isolating the Isle of Wight. This flank attack had still other effects, for the Lower Avon was then only a short river, having a gentle fall of many miles before reaching the sea somewhere near Portsmouth. Subsequently it reached the sea by a short, steep, direct course, and consequently, as the Lower Avon flowed over soft Tertiary strata, it lowered its bed so rapidly as to cut back its valley and capture the whole of the drainage of Salisbury Plain, which previously had continued its natural course to Southampton Water. Clear evidence of this diversion and alteration of drainage areas was forthcoming in the high-level gravels of the Vale of Wardour, containing peculiar fossiliferous Purbeck cherts, which went straight across the present Avon Valley and were found on its west side, showing that when the rivers flowed some 300 feet higher they were tributaries of Southampton Water. Thus the great River Solent had all its headwaters cut off, and was divided into several separate river-basins, each with its own outlet. This happened in late Pliocene times. These flank attacks are still going on further west, and if they continue much longer the breach at Lulworth Cove may widen and deepen in the same way, so that with slight submergence the so-called Isle of Purbeck may become a true island exactly comparable in its geological structure with the Isle of Wight. Though at this early period the Isle of Wight was cut off from the mainland, it was probably at first only separated by a small stream and marshes, and was sometimes an island, sometimes part of the mainland, as the sea-level varied. The final isolation took place at quite a recent period, as the Isle of Wight was probably the ancient Ictis or Vectis of classical writers, to which the ancients traded for tin, and which is described as being cut off at high tide, but connected at low tide by a narrow causeway. The causeway was probably the ledge of Bembridge Limestone which swept across what is now the Solent from Yarmouth to Hurst Castle, and was intact 2000 years ago. It has now been destroyed by the attacks of the sea, and was apparently impassable at the Roman occupation, for the roads then led to a ferry further east and out of the run of the sea.

Dr. J. W. Evans thought that the submergence which was the immediate cause of the separation of the Isle of Wight was connected with the disappearance of glacial conditions from this country. The presence of accumulations of ice appears to cause a local lowering of the earth's crust accompanied by compensatory elevation in adjoining areas which, like the south of England, were unglaciated. When the ice passed away these movements were reversed in direction, as is now seen in Scandinavia. The period of elevation in our southern coast coinciding with the maximum of the glaciation of the British Isles was one of great precipitation, and it was then that the

river valleys were excavated, or at least deepened, the submergence of which had given rise to our magnificent harbours. The discussion was continued by Profs. W. W. Watts, E. Hull, and others, and Mr. Clement Reid, in replying, pointed to the angles at which the tributary streams entered the main valley as confirmatory of his views. The slope of the ancient river-course from the Purbeck outcrops to the sea was almost that of the present river. Pebbles of Purbeck chert were now in a different drainage area from their source.

The earlier hours of Monday were devoted by the geologists to a joint discussion with Sections E and K on the relation of the Glacial period to the plant population of the British Isles, a report of which will be given by Section K (Botany). At 12 o'clock Section C reassembled in its own room, when papers were read by Mr. W. B. Wright and Mr. A. R. Horwood. Mr. Wright, in describing the Lower Carboniferous of the Bundoran district of South Donegal, gave an account of recent investigations by officers of the Geological Survey on the fossils of this area. The Lower Limestone has a conglomeratic base resting on the gneiss, the Lower Limestone Shale being completely absent. The study of the brachiopods and corals showed that the Carboniferous beds of this area were throughout of Viséan age, and leads to an interesting stratigraphical result, for it establishes palæontologically for this area the transgression invoked by Jukes, on purely lithological grounds, to account for the anomalies of the Lower Carboniferous series in various parts of Ireland. It shows, moreover, that this transgression reached the Bundoran district about the end of Tournasian or the beginning of Viséan times.

Mr. W. B. Wright also directed attention to the existence in a number of inland lakes in South Donegal and the Western Isles of Scotland of submerged pine-tree stools in position of growth. They occur at a level several feet beneath that of the outlet, which, being in many cases over broken rock or boulder-clay, precludes any explanation of a rise in the water-level due to peat growth. These cases are unquestionably similar to some described in Sweden, and are probably due to a drier climate, during which the lakes rarely had any overflow. He pointed out, however, that the mere presence of forests in the catchment basin might, by checking drainage and promoting transpiration, have in itself caused the partial drying of the lakes.

Mr. Horwood's papers dealt with some new Rhætic fossils from Glen Parva, and with the shell-layer in Mollusca.

On Tuesday, September 2, Mr. R. W. Hooley read a paper on the discovery of remains of *Iguanodon mantelli* in the Wealden beds of the Isle of Wight, in which the existence of two forms, a smaller and a larger, as in Belgium, was revealed. These variations he attributed to sexual rather than to specific differences. He exhibited a model in wood of the pelvic bones which showed a remarkable balance, and the bones gave evidence that the animal was fitted for bipedal progress, the pressure of the heavy tail upon the pelvic bones enabling it easily to assume an upright position.

Prof. E. S. Moore, of the State College, Pennsylvania, described beds on the border of the Appalachian system which comprised a complex series of impure limestones and sandstones forming a transition between the Cambrian and Ordovician, which included calcareous and siliceous oolites and beds of chert and limonite. The oolites form thin and irregular beds covering an area of more than forty square miles. The calcareous variety probably owes its origin to a mixture of sand grains and calcium carbonate, and to the fact that there were frequent alternations from a condition of deposition of limestone to a disintegration, solution, and redeposition of this rock. The evidence for this conclusion is found in the fact that the oolites occur in a complex mixture of calcareous sandstone and limestone, with alternations to thin beds of limestone-conglomerate, and also that sand grains or fragments of sandstone usually form the nuclei of the concretions. The siliceous oolites originated by replacement of the calcareous concretions, because they occur together, and the former grade into the latter. The source of the silica is to be found in the chert nodules and in the sand grains occurring in the limestone. The chief solvents for the silica are believed to have been organic acids and meteoric water.

Following this paper Prof. Moore gave a lecture on the pre-Cambrian beds of Ontario, illustrated by a fine series of lantern-slides. The Rev. Dr. Irving described a freshwater limestone in the Lower Eocenes of the northern flank of the Thames Basin, and a remarkable greywether or sarsen stone, and Mr. T. Ross Thomson exhibited lantern-slides to explain the various forms of the Wealden ostracoda.

Dr. W. F. Hume, of the Egyptian Survey, described the first meteorite recorded in Egypt, and exhibited specimens. It fell in the neighbourhood of the Alexandria-Cairo Railway, about 44 kilometres E.S.E. of Alexandria, and was seen by numerous natives. All accounts agreed that the stones fell out of a clear sky from the north-west, appearing as a white cloud variously estimated from 1 to 3 metres long. The meteorite exploded, breaking into several fragments, the fall being accompanied by a thunderclap. Numerous specimens were obtained from localities lying in a north and south line, the extreme points of which were separated about 1½ miles from each other. They are all characterised by an intense black and highly polished varnish of iron oxide, coating a green granular rock resembling a dunite, and probably mainly olivine.

In addition to the older committees of research, new committees were appointed to deal with excavations on Creechbarrow Hill, Dorset, and in the Coralline Crag at Sutton, at the base of which chipped flints had been recorded.

The instruction and pleasure of the geologists was much enhanced by excursions to the Portsmouth Waterworks and the Isle of Wight. Saturday's full-day excursion, under the able direction of Mr. G. W. Colenutt, was very successful, and enabled the members to see the lowest beds of the Wealden anticline at Brook Point and the wonderful sections of vertically tilted Chalk and Tertiaries at Alum Bay.

AËRONAUTICS AT THE BRITISH ASSOCIATION.

THE feeling produced by the discussion on the principles of flight, which took place at Portsmouth on September 4 at a joint session of the Sections of Mathematical and Physical Science, and Mechanical Science, of the British Association, is one of disappointment. The expressed purpose of Mr. A. E. Berriman, who opened the meeting, was to ask for the serious attention of matured scientific minds to be directed to a variety of specific problems that have suggested themselves to students of aëronautics during the recent development of flying-machines; but the discussion following his thoughtful and suggestive paper practically ignored the lines for debate that he had indicated, and the net result was to produce a mass of mainly irrelevant remarks.

The subjects to which Mr. Berriman confined his remarks were :—

(1) A consideration of the efficiency of the aëroplane as represented by the ratio of thrust to load, suggesting certain basic formulæ, and insisting on the relative importance of skin-friction.

(2) The necessity for evidence showing how the effective angle of a plane and its effective dimensions might be measured.

(3) The question of stability.

In reference to these subjects, he said that an hypothesis that aëroplanes were supported in flight by the inertia of the air led to the necessity of finding plausible expressions for mass acceleration. Two dimensions of the mass of air deflected were plausibly functions of the span and the chord of the plane; the third, which defined the depth of the stratus engaged and was known as the "sweep," was taken as the empirical function of the chord. Acceleration was obviously a function of the angle of the plane, and it was suggested that the angle should be measured by "the angle of deflection" at the point of intersection of two tangents drawn to the entering and trailing edges of the plane.

In order to extend the premises to cover a plausible expression for the resistance to flight and power expended, it was necessary to adopt a value for skin-friction. At present Zahm's formula was adopted, but the matter needed further research. Skin-friction was of such fundamental importance in aërodynamics that it was imperative to put it upon an accepted basis analogous to the position occupied by normal pressure. The coefficient of flight, representing the resistance per unit load, might be shown to be independent of speed, and to depend on the angle of the plane, and, further, to have a minimum value depending on the coefficient of skin-friction.

On the present hypothesis the minimum coefficient of flight obtained with planes of a very small effective angle—about 5°—such as would necessitate flying at much higher speeds than had hitherto been realised. The existence of an angle of least resistance was very important in connection with the problem of variable speed machines. Body resistance in a practical aëroplane was a supplementary resistance to that of the planes, and should always be considered as such.

Turning to the question of stability, in practical aëroplanes natural stability, both longitudinal and lateral, was mainly based on the principle of the dihedral angle. The acentric centre of gravity, in which the principal masses were placed well below the centre of pressure, was frequently suggested as a stabilising influence, but the permanent existence of a couple between the centre of gravity and the centre of pressure indicated liability to pronounced oscillation and did not find general favour.

Apart from the question of stability, progress in flying-machine design was mainly a problem of increasing the efficiency of the machine. The need for further information on such subjects as the effective angle of the plane, sweep, skin-friction, and other similar problems that come within the province of research work in physical science, was all-important. If the aëroplane of the future was to carry heavy loads and to fly far and fast, it needed to be more efficient than the aëroplanes of to-day.

Dr. W. N. Shaw, who followed, spoke of the dangers to aviators that lay in the constant fluctuations in the speed and direction of air-currents, and pointed out that over sea the oscillation of the wind speed was generally less than that over the land.

Prof. Petavel discussed the various suggested means of obtaining stability from the practical aviator's point of view, and stated his opinion that, given an aëroplane with a fair proportion of natural stability, the experience and control of the pilot might be very well left to supply the rest.

The subject of motors was broached by Mr. Beaumont, who said that, so far as the engine itself was concerned, it was very questionable whether any great increase in either the mechanical or dynamic efficiency could be made; and Sir William White, in the course of some general remarks, stated that the question of propeller efficiency must be dealt with, as in the case of ships, experimentally, by means of models.

THE INSTITUTE OF METALS.

THE annual autumn meeting of the Institute of Metals was held at Newcastle-on-Tyne on September 20–22. The Lord Mayor (Sir W. H. Stephenson), in offering a welcome to the institute, said the institute has made substantial progress with the objects it has in view, to serve the industries connected with the non-ferrous metals in a similar manner to that in which the Iron and Steel Institute has served the iron and steel trades. Research work to meet the needs of industrial development is clearly needed. Such work is constantly in progress at the National Physical Laboratory and in the universities and the university colleges. The Institute of Metals affords a means of communication among the many workers in the field covered by its activities, and the knowledge acquired by research can thus be applied to practical work. An important research which illustrates the services which such an institute may render is being carried out by the Corrosion Committee. Sir Gerard Muntz, in acknowledging the welcome, referred to the research on the causes of corrosion in condenser tubes. He said that a plant which should imitate as closely as possible the conditions obtaining in a marine condenser is being erected at Liverpool, and will be ready for inspection and testing in a few weeks. It is intended to investigate the conditions obtaining under Admiralty and commercial conditions, and it is believed that a large number of the baffling problems connected with corrosion can be investigated adequately. Generous assistance has been given by the University of Liverpool, but additions to the research fund are urgently needed, as the work, to yield useful results, must extend over a period of two or three years. Several papers were afterwards read and discussed, and the following brief summaries will indicate their scope.

Mr. J. L. Haughton and Prof. T. Turner contributed a paper on volume changes in the alloys of copper with tin. The work described is a continuation of previous researches on the changes in length which occur in a cast bar during and after solidification. The method employed has been that of applying an extensometer to one end of a cast bar while the other was kept fixed. The apparatus employed has been modified in order to allow a single operator to observe both pyrometer and extensometer readings at the same instant, and to record these results by means of a chronograph on a paper tape. There are four maxima in the expansion curve, and three of these, with about 10, 46, and 65 per cent. of tin respectively, agree with the "crystallisation interval" as determined from the accepted equilibrium diagrams.

The aim of a paper by Dr. W. M. Guertler, on the electrical conductivity and constitution of alloys, was to direct attention to the property of electrical conductivity in its bearing upon the practical determination of the constitution of alloys. The relationship between concentration, temperature, and any given property—electrical conductivity, specific volume, magnetism, &c.—is best brought out by the employment of a coordinate system, as in the equilibrium diagram. The converse problem is one of great importance, viz. that of obtaining the equilibrium diagram (when it is unknown) by projection from these surfaces on to the basal plane. The best method for the determination of the equilibrium diagram is known by the name of "thermal analysis." Dr. Guertler discussed the limitations of "thermal analysis," and in particular explained why it fails in those cases where, as so often happens in practice, a state of complete stable equilibrium is unattainable within a comparatively short interval of time.

In a paper by Mr. D. R. Pye, on the mechanical properties of hard-drawn copper, the lack of any satisfactory definition of standard hard-drawn copper was pointed out. Experiments were described confirming a suggestion made by Mr. A. P. Trotter that the tensile strength per square inch diminishes with increase of diameter according to a linear law. It was also shown that the elongation at fracture for similarly manufactured wires depends very much on the diameter, being considerably greater for larger sizes of wire. It was suggested that a satisfactory definition of hard-drawn copper wire would fix a minimum tensile strength per square inch given by the formula

$$T = 30 - 20D,$$

and a minimum elongation per cent. at fracture given by the formula

$$e = 5D,$$

where D = diameter in inches.

In a paper by Mr. George Hughes, on non-ferrous metals in railway work, he placed on record some of the methods of working, and uses pertaining to, the non-ferrous metals in locomotive and carriage construction. A short account of the bearing metals used under the name of white metals was included, together with a note on non-ferrous metals and alloys used in the railway carriage department.

The main object of Mr. C. A. Edwards's paper, on further notes on the nature of solid solutions, was to deal with points of interest raised in the discussion on a previous paper by Mr. Edwards on the same subject, and to stimulate further discussion.

The paper by Prof. H. Louis, on the failure of a brazed joint, gave an account of the investigation of the cause of

a failure in the braze of a steam-pipe on a steamer, undertaken at the instance of the Board of Trade. The failure was due to corrosion following certain well-defined lines in the brass, and he traced the cause of these lines to the presence of small quantities of lead and tin in the original brazing spelter. The lead-tin alloy, separating out between the crystals of brass, formed planes of weakness that gave access to the corroding solutions, and this brought about the gradual corrosion of the entire brazing material.

A paper by Dr. Walter Rosenhain and Mr. S. L. Archbutt, on the alloys of aluminium and zinc, described a detailed investigation of the constitution of the alloys of aluminium and zinc which was undertaken in connection with an extended research on the light alloys of aluminium. A series of cooling curves were taken at a slow rate of cooling, and in many cases the ingots of the alloys were subjected to prolonged annealing before the cooling curves were taken. The microscopic examination of the cooled alloys was supplemented by the study of specimens which had been annealed and quenched at definite temperatures. The results were embodied in an equilibrium diagram which differs from the diagram of Shepherd; these differences result from the discovery of the existence of the definite compound Al_2Zu_3, which has a stable existence only between 443° C. and 256° C.

It was urged by Mr. Paul T. Bruhl in a paper on the corrosion of brass, with special reference to condenser tubes, that so important a subject as the corrosion of brass by sea water should induce steamship companies to keep records bearing on the subject. The conclusions arrived at by the author were:—That the presence of air or an increase of temperature up to a certain point accelerate corrosion. That iron, nickel, and small amounts of lead are injurious; tin up to about 1 per cent., large amounts of lead, and aluminium are useful in diminishing corrosion. That the inlet pipe and the condenser plates should preferably be made of brass. That the condenser should be protected against stray currents. Protective coatings are not recommended.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ST. ANDREWS.—Mr. W. O. Redman King has been appointed demonstrator in zoology and lecturer on embryology, in succession to Dr. J. R. Tosh, who has returned to Australia.

BIRMINGHAM.—A lectureship in civic design and town planning has been established in the University of Birmingham. The cost will be defrayed by the Bournville Village Trust, which was founded by Mr. George Cadbury as a practical attempt to solve the problem of the housing of the less wealthy classes. Mr. Raymond Unwin, who is well known for his work in connection with the Garden City at Letchworth and the Hampstead Garden Suburb, has accepted the lectureship for the first year, and will begin his course during the present session. The lectureship will be associated with the department of civil engineering, but it is hoped that students of other faculties will take advantage of the lectures, especially those who are working in the course on social study.

THE new science buildings at Shrewsbury School, which have been erected at a cost of 2500*l.*, will be opened on October 20 by Dr. Francis Darwin, F.R.S.

ON Wednesday, October 4, at 4 p.m., a public inaugural lecture will be delivered at King's College (University of London) by Dr. William Brown on "Emotions and Morals." The chair will be taken by Prof. James Sully.

BY the will of the late Lord James of Hereford, the sum of 3500*l.* is bequeathed to the governing body of Cheltenham College for the purpose of founding "James of Hereford" scholarships at that school. Lord James of Hereford was president of the council of the school.

MR. M. GREENWOOD, jun., will begin a course of lectures and demonstrations on "Statistical Methods and their Applications in Preventive Medicine and Pathology" at the Lister Institute of Preventive Medicine on Monday, October 16, at 5 p.m. This course is open, without fee, to all medical men and to others interested in the subject.

FOUR lectures on "Flies as Carriers of Disease" will be delivered on Tuesday–Friday, October 10, 11, 12, and 13, by Dr. F. M. Sandwith, Gresham professor of physic. The lectures will be delivered at the City of London School, Victoria Embankment, E.C.; they are free to the public, and will begin each evening at six o'clock.

THE calendar for the sixty-third session, that of the present academic year, of the Bedford College for Women gives full particulars of the varied arrangements for the higher education of women made at this constituent college of the University of London. Bedford College was recognised in 1900 as a school of the University in the faculties of arts and sciences, and it is further recognised for preliminary medical studies and for advanced medical studies in chemistry and physiology. The college cooperates in a scheme of inter-collegiate teaching with other colleges of the University for honours and post-graduate work. We notice that the new buildings for the college at York Gate, Regent's Park, London, will, it is hoped, be ready for occupation next year.

THE eighty-ninth session of Birkbeck College commenced on Wednesday, September 27, with an opening address by Sir William Tilden, F.R.S. The classrooms, &c., were afterwards open for inspection, and there was an exhibition in the art school. The college is conducted in relation with the University of London; classes are held both in the day and evening; thirty members of the staff are recognised teachers of the University. There is a very complete curriculum for chemistry, physics, mathematics, botany, zoology, and geology. The laboratories are well equipped with modern apparatus and appliances, and research work is encouraged in all the science departments. According to the calendar, more than 140 students passed some examination of the University during the last session; forty-seven took degrees in arts or science, twenty-one with honours, two the LL.B. degree, one with honours, and several students gained distinction at other universities.

THE Bethnal Green Free Library was founded in 1876 to meet the requirements of a crowded working class and poor borough, and is supported entirely by voluntary contributions. The main library now contains more than 30,000 volumes; the lending section has 8000 more. Commercial, evening, and other classes are held, and free instruction in design, brushwork, needlework, &c., is given to young girls. To earnest students the library is scarcely less than a local British Museum, where skilled artisans may find technical books of service to them in their trades. Free lectures and concerts provide healthful recreation. A deficiency in the annual income of 200*l.* is causing the council some anxiety. In order that the work shall not suffer in any department, the council has opened a reserve fund of 10,000*l.*, and to this the present King has subscribed. Both Queen Victoria, King Edward VII., and Queen Mary also extended their favour to this institute. Donations to the general fund may be sent to the librarian, or to Mr. F. A. Bevan, treasurer, 54 Lombard Street, and Mr. Stephen A. Gard, honorary secretary, will receive donations to the reserve fund.

THE announcements for the present session of the Northampton Polytechnic Institute, Clerkenwell, London, show that day and evening courses have been arranged in mechanical and electrical engineering, in electro-chemistry, technical optics, and horology. The engineering courses include automobile work, aëronautics, and radio-telegraphy. Several new developments have been arranged. In the electrical engineering department, the new generating station, which was opened last winter, is now available for the instruction of senior students. The equipment of this station is very complete in all details of the generation and distribution of continuous and alternating current. In the mechanical engineering department the equipment for experimental work in aëronautics has been increased, and it is hoped that work of a research character will be done during the coming winter. New departures have been made in the day work of the technical chemistry and of the horological departments by the institution of morning classes for apprentices in workshops. In these classes students, all of whom are engaged in commercial workshops, are in attendance from 9 a.m. to 1 p.m., and

spend the afternoons in their employers' workshops. The experiment is interesting as an attempt to solve the problem of providing instruction for the artisan without the drawbacks involved in attendance at evening classes after a strenuous day's work. In the evening classes an important series of lectures on illuminating engineering is being given jointly by the electrical engineering, technical chemistry, and technical optics departments.

THE calendar of the University of Bristol for the session 1911–12, which is now available, reminds us that the University of Bristol Act was passed in 1909 only, and that excellent progress has been made since that date in establishing the various departments of the University which is to serve the west of England. Several institutions in the neighbourhood have been affiliated with the University. The work of the faculty of engineering in all its branches is carried on in the Merchant Venturers' Technical College, agreements between the University and the Society of Merchant Venturers having been signed in July, 1909, and May, 1911. In July, 1910, the Royal Agricultural College, Cirencester, became associated with the University for the purpose of instruction in agriculture, forestry, veterinary science, and kindred subjects. Two theological colleges in Bristol are similarly associated for instruction in theology and certain linguistic subjects. There are, in addition, day training colleges for teachers, and the University is fortunate in the number of institutions near it open to students of medicine for hospital practice and clinical instruction. A public health laboratory has been established to enable medical men in the area to obtain trustworthy information and reports upon pathological material, and of placing at the disposal of authorities dealing with drinking water, persons concerned with the supply or consumption of milk, and those engaged in manufacturing processes, the resources of a properly equipped bacteriological research laboratory. It is clear that the University authorities are fully alive to their opportunities of influencing the life and industries of the counties surrounding the University, and that it will not be long before the good effects of higher instruction in the various branches of knowledge will follow.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 18.—M. Armand Gautier in the chair.—Ch. **Lallemand**: The deformations resulting from the mode of construction of the international map of the world on the scale of one millionth. The author establishes simplified formula for the construction of the map, having regard to the accuracy possible with the scale chosen. It is shown that the linear and angular errors, due to the method employed, would be much less than those due to the hygrometric deformations of the paper on which the map is printed.—Edm. **van Aubel**: Hall's phenomenon and the transversal thermo-magnetic effect in graphite. Details of measurement of the thermo-electric power of a graphite-copper thermocouple. This was found to be +17·8 microvolts per degree between 21·0° C. and 57·6° C., and 18·1 microvolts per degree between 20·9° C. and 98·55° C.—Georges **Baume** and Albert F. O. **Germann**: Fusibility curves of gaseous mixtures: the oxonian systems formed by acetylene, ethylene, nitric oxide, and methyl oxide. Diagrams are given showing the fusibility curves of the systems (methyl oxide-acetylene), (methyl oxide-ethylene), and (methyl oxide-nitric oxide). Each of these curves shows a clearly marked angular point corresponding to the molecular proportions $((CH_3)_2O+C_2H_2)$, $((CH_3)_2O+C_2H_4)$, and $((CH_3)_2O+2NO)$. —J. **Bougault** and C. **Charaux**: Lactarinic acid, a keto-stearic acid extracted from some fungi of the genus Lactarius. This acid is present in the free state in *L. theiogalus*, *L. plumbeus*, *L. pyrogalus*, and *L. uvidus*, and can be extracted by boiling alcohol. The properties of the acid are described; it is shown to be a ketostearic acid of the composition $C_{18}H_{34}O_3$.—P. **Gaubert**: The indices of refraction of some crystalline liquids. Measurements of the refractive indices of propionate, benzoate, acetate, and caproate of cholesterol are given.—E. **Kayser** and H. **Delaval**: Contribution to the study of ropy bread.—Charles **Nicolle**, A. **Conor**, and E. **Conseil**: The nature and the seat of the pathogenic agent in exanthematic typhus. Experiments are adduced in support of the hypothesis that the virus is localised in the leucocytes. The blood was separated by centrifugation; the white corpuscles proved on inoculation to be the most virulent; the plasma is less active, and appears to owe its poisonous action to the leucocytic débris difficult of removal; the wasted red corpuscles are inactive. The blood serum was proved to be inoffensive to man, and the cephalorachidian fluid, devoid of cells, proved to be also inactive.

DIARY OF SOCIETIES.

TUESDAY, OCTOBER 3.

FARADAY SOCIETY, at 8.—The "Paragon" Electric Furnace and Recent Developments in Metallurgy: J. Hårdén.—Progress in the Electro-metallurgy of Iron and Steel: Donald F. Campbell.—The Hering "Pinch Effect" Furnace: E. Kilburn Scott.

WEDNESDAY, OCTOBER 4.

ENTOMOLOGICAL SOCIETY, at 8.—Report on a Collection of Bombyliidæ (Diptera) from Central Africa, with Descriptions of New Species: Prof. Mario Bezzi.

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