THURSDAY, JANUARY 14, 1909.

CONSTRUCTION AND USE OF CRANES.

Cranes: their Construction, Mechanical Equipment, and Working. By Anton Böttcher. Translated and supplemented with English, American, and Continental Practice by A. Tolhausen. Pp. xvii+510. (London: A. Constable and Co., Ltd., 1908.) Price 42s. net.

MODERN developments of means of transit, especially in the direction of the transhipment of heavy goods, have made it necessary that rapid and powerful lifting gear should be devised, and *pari passu* with the developments of heavy engines and wagons, heavy ordnance and large ocean liners, there has been an equally interesting and important advance in the construction of rapid and heavy cranes.

The book before us has for one of its aims the presentation of the progress that has been made, and with this end in view many types of cranes are described and discussed in detail, and illustrated by photographic views of general arrangements, together with dimensioned drawings of more than seventy particular examples.

The book is, however, by no means simply a descriptive work, as all parts of cranes that lend themselves to theoretical treatment are dealt with in a sound manner. The first part of the book deals with first principles in crane-building practice, and to those who have had a preliminary training in the elements of applied mechanics should be of interest and of great value in showing their applications to definite design problems, as well as for the immediate object in view. For example, the use of the funicular polygon in the resolution and composition of forces is illustrated, and the laws of motion are used to determine the time of motion, and the forces required to give momentum to the travelling portions of various forms of cranes. It also includes an interesting paragraph on "efficiencies," and, along with other valuable tables, one giving the efficiencies of crane parts. In the paragraph on struts only Euler's formulæ are given. This is to be regretted, as it is generally agreed in this country that more trustworthy results are obtained by such formulæ as Rankine's or Tetmajer's. Part ii. is devoted to the general arrangements of cranes, and opens with a concise summary of the local influences which decide the character of cranes in different circumstances, followed by general descriptions of many types, from the old-time hand winches to the most modern electric-driven travelling cranes.

Part iii. deals with crane-driving principles; driving by hand, shafting, steam, water and electricity are treated, and the principles involved in the determination of the power required to lift a given load at a given speed, and the gear ratios are dealt with in detail. The subject-matter of the hydraulic and electrical sections is particularly good, but the translation is not all that could be desired, as the meaning is at times somewhat obscure, especially in the electrical section, which, we fear, will hardly be intelligible except to those very familiar with the theory and practice of motors. The translation is surely not happy when, in the hydraulic section, a sentence is rendered as "the rams beget larger diameters with equal lifts." In one or two cases the obscurity is intensified by slips in proof-reading, as, *e.g.*, on p. 102; the velocity of the water through the valve is proportional to the difference of pressure in the valve box and cylinder, so that in the formula, p_0 should be replaced by $p_0 - p_1$. We were some time before we could put a meaning to the following, which opens the paragraph on speeding up electric motors:—"The current curves represented in Fig. 257—corresponding with full cut-off initial resistance to the inscribed circumferential moment—are independent," &c., and even now we are in doubt as to the author's meaning. It is also, we think, not usual to speak of the back E.M.F. of a continuous-current motor causing current lagging. In the paragraph on "running down" we were rather held up for the moment by "To hold the load in a fixed position the simple running down will suffice in many cases," until we realised that the translator meant that the switch is in the running-down position, and the mechanical friction of the gearing, &c., is sufficient to prevent the load running down.

We do not remember in English works to have met with the method used by the author of determining the ratio of the areas of the lifting rams and the valve openings of hydraulic cranes, by consideration of the difference between the velocity of lifting and lowering. The method, though simple and well known to some English designers, has not received the attention it deserves, and is well worth careful study by those engaged in this branch of designing.

Part iv. considers in a very complete manner crane parts and accessories, and designers of all classes of machinery will find the information given valuable. This is followed by a section devoted to the design and calculation of crane girders. The designs of riveted joints and of various forms of girders are considered in a very practical manner, and where theory fails current practice is referred to. A number of sound hints are given, as, for example, when the author is dealing with the stiffening of travelling girders, he remarks:—

> "As practice alone can guide us in this respect, it is advisable, when such exigencies can be drawn upon to draft the design in such a manner that eventual stiffening may be resorted to if found to be requisite in testing or working."

The determination of the maximum stresses that can occur in the members of a lattice girder, due to the crab moving over the girders, is dealt with in a way that should appeal to those who are familiar only with the ordinary stress diagrams, the influence line being deduced from a number of diagrams drawn from a single load fixed at a different point for each of the diagrams. It is, we think, unfortunate that the very simple method of influence lines is not better known, as without the labour involved in drawing stress diagrams the unit load diagram or "influence line," for any member, in the top boom,

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for example, can be at once drawn by erecting an ordinate at the junction of the diagonal of the same bay with the bottom boom, equal to the product of the two parts into which the junction point divides the span, and joining the end of the ordinate with the ends of the span. An equally simple construction gives the line for any member of the bottom boom, and the influence lines for all the diagonals can be drawn by first drawing two parallel lines through the ends of the span; then if verticals are drawn through the end points of any bay to meet these respective lines, and the two points of intersection are joined, the line thus drawn, together with the two parallel lines, is the "influence line" for the given bay.

Part vi. is devoted to the description of, and calculations for, types of German, English and American cranes. This part of the book is particularly valuable, as theory and practice supplement each other in a way that is really helpful to designers. The last three sections are devoted to specifications, useful tables, and a valuable index to articles and papers on cranes. The book is excellently printed and well illustrated on very stiff paper. It can cordially be recommended to designers, builders, and users of all kinds of lifting and carrying machinery, and we can hardly think of a branch of mechanical engineering in which the book will not prove useful for reference. Students will also be well repaid by a careful study of the designs given and the calculations therewith, as they will be able to appreciate, perhaps, better than in any other way, the limitations of the theories upon which they are apt to place implicit trust.

F. C. L.

AN OXFORD CHAMPION OF DARWINISM.

Essays on Evolution, 1889–1907. By Prof. E. B. Poulton, F.R.S. Pp. xlviii+480. (Oxford: Clarendon Press, 1908.) Price 12*s*. net.

ON July 1, 1858, an epoch in the history of science was created by the reading, before the Linnean Society of London, of the papers by Darwin and Wallace on natural selection; and on July 1, 1908, the fiftieth anniversary of this momentous occasion was appropriately celebrated under the auspices of the same society. The publication of Prof. Poulton's volume is especially well timed, for it appears while the Darwin-Wallace commemoration is fresh in the minds of all, and while the weighty utterances by which the veterans Wallace and Hooker themselves so greatly added to the interest of the proceedings on that occasion are still a recent memory.

Among those men of science who have found their chief inspiration in the work of Darwin and Wallace, no one has laboured with greater perseverance and success than Prof. Poulton, and the present collection of essays embodies the main results of his investigations during his tenure of the Hope chair at Oxford. The memoirs have all in one form or another appeared before, but the author is not by any means content with a mere reprint of his former publications; he has, on the contrary, spared no pains to bring the treatment of his various topics up to date, and a comparison with the lectures and addresses in their original form will show that in many cases this must have involved considerable labour. But with so fertile and so rapidly growing a subject as that which Prof. Poulton has made his own, a period of nineteen years, which is that which separates the first essay in point of date from the present time, gives opportunity for enormous accessions of material, and almost inevitably involves some modification, if not in the principles, at least in the details of interpretation. The author has acted fairly towards his readers by ensuring that the essays here reprinted, though preserving the general form and tone in which they were originally framed, should nevertheless be the expression of his own present views, and should embody the principal points of evidence that have since come to light. The keynote of the book is the all-importance of natural selection, as propounded by Wallace and Darwin, in the interpretation of the past history and present condition of organic nature. The essays form a powerful reinforcement of what is properly and distinctively called the Darwinian theory of evolution, and should tend to reassure those weaker brethren who have allowed themselves to be persuaded or terrified into losing confidence in the work of the two great founders of rational evolutionary doctrine.

The greater number of Prof. Poulton's arguments and illustrations are naturally drawn from the wonderfully rich domain of insect bionomics. The way in which the great Oxford collection, so liberally established by Hope, and so assiduously tended by Westwood, has been made of late years to subserve the cause of scientific research and progress, especially in the unravelling of intricate problems of evolution, is one of the most remarkable features in the recent history of the University. The development of such studies in Oxford, of which the present volume is only one among many manifestations, should be a matter of cordial congratulation to the present Hope professor, on the part, not only of entomologists, but of all who take a rational interest in any department of biology.

Space would fail us in the attempt to give an adequate account of the contents of this stimulating book. A bare enumeration must suffice. First comes a discussion upon the age of the earth, comforting to those biologists who have been disturbed by certain physical calculations now in great measure abandoned. Next we have the question asked and answered, "What is a species?" Essays follow on the theories of evolution which rival or antagonise Darwin's, on the nature of heredity, and on the remarkable anticipation of Galton and Weismann by the anthropologist James Cowles Prichard. The Birmingham lecture on Huxley is of especial value, as it not only defines and accounts for the precise attitude of that great biologist towards the Darwinian theory, but also contains one of the most forcible and convincing pleas that we have yet seen for a more rational use in education of our present system of examinations. The three concluding essays, which show an immense command of facts, deal in a masterly manner with the fascinating subject of mimicry. They are especially remarkable as indicating the gradual trend of opinion towards a large substitution of the Müllerian interpretation for that of Bates.

A word must be added on a subject of some delicacy. Prof. Poulton's introduction, in which he deals with certain of the assertions and pretensions of the English school of Mendelians, is undeniably controversial, and even in places personal. The author has in several quarters been taken to task for his polemics. This reminds us of the old complaint:—

> Cet animal est très méchant;
> Quand on l'attaque, il se défend!

Controversy is necessary for the progress of science. Personalities, we think, are, as a rule, better avoided; but there are cases when the tone adopted by the assailant makes it impossible to offer an effective resistance except by the employment of methods which would at ordinary times be left unused. Prof. Poulton shows that he warmly appreciates the interest and value of Mendel's discovery, and the keenness and industry with which it is being followed up, but we think that he is justified in his protest against an attitude necessarily tending to discourage the younger workers in a field which, since the ground was first broken by the great naturalists lately commemorated and honoured, has proved the most fertile of all within the wide realm of the sciences of life.

The book is fitly dedicated to Prof. Meldola, to whom all Darwinians owe an immense debt of gratitude. It is furnished with an admirable index, and both paper and printing are worthy of the traditions of the Clarendon Press. F. A. D.

ARCHÆOLOGY IN GREECE.

The Annual of the British School at Athens. No. XIII., Session 1906–7. Pp. xi+488+plates. (London: Macmillan and Co., Ltd., n.d.) Price 25*s.* net.

IN this volume of the "Annual" the director and students of the British School at Athens describe the excavations at Sparta during the year 1907. The work at the temple of Artemis Orthia was carried on very successfully, and the results are most important for our knowledge of Laconian art of the early period (eighth to sixth centuries B.C.). Taking all in all, the early Spartans seem to have been much more civilised than one would have expected; and if, as is supposed by Mr. Droop, the so-called Cyrenaic style of vase-painting is really Spartan, they seem to have been originative artists.

The temple of Athena of the Brazen House, where, as we read in all our Greek histories, the renegade victor of Platæa, Pausanias the king, was walled up and died miserably, has also been excavated, with interesting results. We do not note that any particular conclusions as to possible date of foundation, &c., are drawn from the orientation of these buildings.

The two most interesting articles other than these are the continuations of Mr. Dickins's very able critical article on the sculptor Damophon of Messene, and of Dr. Mackenzie's on Cretan Palaces. Dr. Mackenzie now completes his argument against Prof. Ridgeway on the one side and Prof. Doerpfeld on the other as to the precise signification of the great discoveries in Crete. He is doubtless right against Prof. Ridgeway in maintaining that the people who built the palaces of Knossos and Phaistos were not Indo-Europeans, and did not speak any kind of Greek, and against Doerpfeld in denying that they had any Achæan blood, or that their work shows any Achæan influence. In fact, the Achæan theory was knocked on the head by Prof. Ridgeway's trenchant criticism in his "Early Age of Greece," and Prof. Doerpfeld's Achæanised Carians have been knocked on the head by Dr. Mackenzie.

The "Minoans" may have been akin to the Carians, but not to the Achæans, who were Aryan Greeks, which the Carians, Lycians, and others were not. Where Prof. Ridgeway went wrong was in making his "Pelasgians" (=Minoans) Aryans. Whether the Minoans were Pelasgians or not we cannot say; Prof. J. L. Myres has lately shown how very useless for practical purposes this elusive ethnic name is. Prof. Ridgeway made the Pelasgi a pre-Achæan wave of Aryan invaders. But if so, they cannot have been the builders of the Cretan palaces, who came from the south, not from the north. Dr. Mackenzie makes them non-Aryan like the Minoans, but thinks that, driven from Greece by the Aryan Achæans, they fell back upon their Minoan kinsmen in the islands and Crete, and overthrew the Minoan culture, building amid the ruins of the labyrinthine Minoan palaces their own halls of the Mycenæan and Tirynthian type, which we have hitherto regarded as Achæan. Thus the Minoans would be pre-Pelasgic as well as pre-Achæan. Dr. Mackenzie regards the well-known "Warrior Vase" from Mycenæ as Achæan, no doubt correctly, and the geometric pottery of the Dipylon as Dorian, a view which, although it was generally accepted a few years ago, has its difficulties. Perhaps it was Achæan too. If it was Dorian, why is it found in Attica? Are we to suppose that the Athenians of set purpose deleted from their history the fact that their land had at one time been Dorized?

H. R. HALL.

SYLVESTER'S MATHEMATICAL PAPERS.

The Collected Mathematical Papers of James Joseph Sylvester. Vol. ii. (1854–73). Pp. xvi+732. (Cambridge: University Press, 1908.) Price 18*s.* net.

AMONG the 110 papers contained in this volume there are five or six which represent the author at his best. First of all there are three on Newton's rule for the discovery of imaginary roots of equations; here we see Sylvester working his way from a laborious and partly tentative method to the simple and beautiful proof which is reproduced in Todhunter's "Theory of Equations." (It is not impossible, by the bye, that there may be a series of cubic functions of the coefficients which would give information supplementary to that afforded by Newton's series.) Then there are two papers on the motion of a rigid body containing a well-known addition to Poinsot's theory; these show admirably Sylvester's power of combining analytical and geometrical methods. Finally, there are the notes of his King's College lectures on the partition of numbers, which, in spite of their fragmentary form, supply some very interesting reading. They contain, practically, an outline of three distinct methods, that of combining a deficient set of linear equations, that of partial fractions, derived from Euler's generating function, and a barycentric method, or rather a barycentric way of stating the problem and its solution, especially with regard to its definite or indefinite character.

Among the numerous short notes there are many of permanent mathematical interest; for example, those on the twenty-seven lines of a cubic surface, on the involution of six lines in space, on the problem of the fifteen virgins, and so on. But, quite apart from their scientific importance, there is not one of these papers which is not entertaining or fails to illustrate the quaint personality of the author. His passion for coining new terms; his raids upon the Hebrew alphabet; his amusing accounts of the genesis of this or that theorem; such things raise a smile on the face of the reader. But the student of Sylvester's work who realises the power of his intellect and his thoroughly genial and magnanimous character, will end by adopting the attitude of the Eastern lover, who compares the mole on his mistress's cheek to a grain of musk or ambergris, which only enhances her charms.

Nearly at the end of the volume is reproduced Sylvester's presidential address to the British Association. This is memorable for the fact that in the course of it Sylvester scores a point against Huxley—a thing of which not many would be able to boast. Huxley, in an unguarded moment, had declared that mathematics was "that study which knows nothing of observation, nothing of induction, nothing of experiment, nothing of causation," an assertion which Sylvester triumphantly and conclusively shows to be anything but the truth. This address, and many of his occasional utterances, show Sylvester's intense conviction of the importance and dignity of mathematical science *per se*, a conviction that should be shared and expressed by every mathematician, for there is always a risk of the fact being forgotten and the science being neglected, or, still worse, patronised.

Finally, the appendix contains an amusing polemic between Sylvester, G. H. Lewes and others, on the metaphysical nature of space. Like most such controversies, it is nearly, if not quite, a mere logomachy, but it was worth reprinting on account of the eminence of the principal combatants.

The papers, as originally printed, swarm with clerical errors, so that Dr. Baker has no enviable task to perform as editor. To all appearance, the necessary corrections have been made in the most complete manner, and the printing of the text, with its complicated formulæ, and sometimes uncouth symbols, leaves nothing to be desired.

G. B. M.

A GEOGRAPHY OF RUSSIA.

Russland. By A. von Krassnow and A. Woeikow. *Länderkunde von Europa.* By A. Kirchhoff. Third Part. Pp. viii+336; 18 plates, 21 figures. (Vienna: F. Tempsky; Leipzig: G. Freytag, 1907.) Price 22 marks.

THE growing use of the Russian language for scientific publication in Russia renders summaries of existing knowledge about that vast country increasingly necessary. We accordingly welcome this authoritative account of the geography of European Russia by Prof. von Krassnow, of Kharkhov, published in Kirchhoff's "Unser Wissen von der Erde," of which it forms the third volume of the series on Europe. The book labours under one serious disadvantage. It is printed in the old eye-straining German type, and readers who are careful of their eyesight will prefer works printed in characters that can be read with less fatigue.

The volume is closely printed, its information is detailed and concise, and it is illustrated by 18 maps and 21 other figures, all given as blocks in the text. The sketch-maps and sections are so useful that we can only regret that there are not more of them.

The geography of Russia has many problems of especial interest, as it is the most truly continental State in Europe, and is inseparably linked with Asia. It offers the most complete contrast available in Europe between typically continental conditions and those of the peninsulas of western Europe. Whereas England has one mile of coast line to twenty-seven square miles of land, Russia has only one mile of coast to every 260 square miles. Its climate marks clearly the effect of this continental character, and present knowledge of the climate of Russia is summarised in one of the most important chapters in the volume which is contributed by Prof. A. Woeikow.

The geography of Russia reflects in the wide range of its units the comparative simplicity of its geological structure. The constituent elements are developed on so great a scale that Russia exhibits the phenomena of marine transgressions with a clearness equalled in no other State of Europe. Ancient rocks are not very extensively developed, for so much of the country is deeply buried under drifts; but old rocks form the wide "Russian platform" of Suess in south-western Russia, and build up the long chain of the Urals. There is a valuable chapter on the geography of the Ural Mountains, which brings out clearly its essential structure as a dissected mountain chain with a meridional direction, formed by folding and followed by the displacement of earth-blocks. The population of Russia includes an interesting mixture of races; but it is, however, relatively small, numbering in European Russia less than fifty per square mile. Much of the country is sparsely occupied; of the whole area of European Russia only 26 per cent. is arable land, 19 per cent. is waste, and 39 per cent. is forest. So much of the land being unoccupied, it is not surprising that Russian cartography is backward, and in spite of the distinction of Russian geodesists we are told that the triangulation is incomplete for great parts of the country.

The work includes chapters on the biology and ethnology of Russia, as well as of the remarkable faunal history of the Black Sea; it gives a short but interesting discussion of the density of the population, illustrated by a map, which would have been more readily useful if the index of shading had given reference to another measurement as well as to square-versts. The book concludes with two long and instructive sections on the economic geography and on the towns which will be of great service to those who cannot use the detailed information in the forty-one volumes of the great Russian Encyclopædia (Entsikhlopeditcheski Slovar, 1890–1904).

LOCOMOTIVE ENGINEERING.

Locomotive Performance. By William F. M. Goss. Pp. xvi+439. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1907.) Price 21*s*. net.

The Railway Locomotive. What it is and why it is what it is. By Vaughan Pendred. Pp. xi+310. (London: A. Constable and Co., Ltd., 1908.) Price 6*s*. net.

PROF. GOSS and his assistants in the engineering laboratory of the Purdue University are to be congratulated on the very able manner in which they have carried out their researches on the performance of locomotives, and more particularly the experiments with the two locomotives installed in the locomotive testing plant at Purdue University.

The present volume is an account of the growth of the engineering laboratories at Purdue, the locomotive testing plant being more particularly dealt with, its inception being largely due to the interest taken by the late President Smart, of that university, in conjunction with the late A. J. Pitkin while general superintendent of the Schenectady Locomotive Works. In fact, the success of the laboratory appears to be largely due to the cooperation of the university authorities with the famous locomotive builders at Schenectady, many mechanical engineers being also interested in the success of the laboratory and rendering valuable assistance in many ways. As locomotive engineers, as a rule, base their designs on the result of practice and experience rather than on theoretical considerations, the contents of this volume must be of much interest to them, and we can strongly recommend its careful study.

The contents of the book are divided into five headings, the first four chapters dealing with "locomotive testing," under heading No. 1. These are most interesting, since the inception of the testing plant is described and the many difficulties discussed, the development of the laboratory largely increasing the interest taken by American locomotive engineers in the scientific treatment of the subject.

Chapter v. comes under heading No. 2, and gives a typical exhibit of the performance of a locomotive under varying conditions of speed and cut-off. Fig. 62 is an interesting illustration of the influence of speed on the indicator diagram when running with a late cut-off, making it very evident that both must be considered as having an important influence on the mean effective pressure.

Chapter vi. in part iii. deals with boiler performance, a most interesting subject. The question of locomotive boiler design has come prominently to the front in recent years, and much attention has been given to it. The human factor, however, in the form of the fireman, enters very largely into the question, a fact which our author very carefully points out. Another most important detail of locomotive design is dealt with in chapter xi.; we refer to the smoke-box, or front end, since the efficiency of the engine is very largely due to the correct proportions and arrangement of the blast-pipe and chimney. The arrangement of these details is thoroughly discussed, and the best proportions expressed in simple equations.

Part iv. of the book deals very largely with cylinders, valve gear, and the all-important question of correct balancing. Prof. Goss is to be congratulated on the able way in which he has handled the latter subject; his experimental work as described in chapter xviii. is most valuable, and has added considerably to our knowledge.

Locomotive performance is discussed in part v. of this interesting book, the last chapter of which generalises the many points discussed. Taken as a whole the volume is quite unique; it contains valuable information of a highly scientific nature, and we strongly recommend all interested in locomotive engineering to study it.

"The Railway Locomotive," by Mr. Vaughan Pendred, is a book very different from Prof. Goss's; it is one of the Westminster Series, and we are told that it is intended to bridge over the gaps left by specialisation. What this means is not quite clear; but if it is the intention of our author to describe the locomotive as it is for the benefit of engineers not of the locomotive variety, then he is to be congratulated upon having produced an interesting and useful volume, and one likely to fulfil the object he has in view.

The book is divided into three sections. The locomotive as a vehicle is first treated, and occupies nine chapters, the eighth of which deals with adhesion, and we are pleased to notice that the late Mr. Patrick Stirling's famous "singles" are quoted and referred to as highly successful engines. They will be remembered when many modern monstrosities have gone to the scrap-heap and been forgotten.

Section ii. deals with the boiler, the sectional diagram of which, Fig. 39, is certainly not modern. The author has much to say, naturally, about staying flat surfaces, and the differences in the coefficients of expansion of the copper fire-boxes in the steel shells of locomotive boilers. He here deals with the biggest worries of the locomotive engineer. Locomotive boilers have increased in dimensions in an abnormal manner, and, unfortunately, the bigger the boiler the bigger the wear and tear. Stay bolts are dealt with in chapter xii., and, passing over what the author has to say about Captain Palliser and armour plating, which has nothing to do with the case, we learn that various bronzes have been tried, as well as

Bowling and Low Moor iron. Copper is, of course, the universal practice for stay bolts when a copper fire-box is used. A copper stay bolt screwed into a copper plate with its head carefully riveted over is more likely to stand the wear and tear, since the coefficient of expansion is the same. Leakage at the joints is reduced to a minimum; the action of the fire on the riveted head is far less severe, thus ensuring a far longer life than if the stay was made of a bronze, which naturally wastes with the fire action, the head vanishing, and later on the shank of the stay bolt in the copper plate for the same reason unless replaced in time. Fig. 44 is a good illustration of this wear and tear, although it is probably intended to illustrate a badly worn copper stay many years old.

Given a wider water space, and a pitch of stay bolts less than the usual practice, then with the high pressures now in use no trouble need be anticipated from broken stays, and copper is evidently the proper material to use, since it has to be fitted into a copper plate and both exposed to intense heat.

On the general design of boilers we find much useful information, and reference is made to Mr. Drummond's water-tube fire-box; surely the late Mr. W. M. Smith, of the North-Eastern Railway, had a good deal to do with the arrangement of the water tube, it being originally fitted into the fire-box of North-Eastern Railway engine No. 1619 in a somewhat similar fashion. This engine is not mentioned, by the way, in chapter xxxiii., dealing with compound locomotives, although it is the progenitor of the Smith type of three-cylinder compounds on the Midland and Great Central Railways; that is to say, the engine is fitted with one high-pressure and two low-pressure cylinders, the latter being used as high-pressure cylinders and the former being in equilibrium when starting a heavy train automatically. It is, of course, well known that the three-cylinder Smith compounds on the Midland have been fitted with a special regulator valve, which does away with the Smith automatic valve.

The question of compound working of locomotives has been a prominent one for a long time, and we cannot congratulate the author on the way in which he has dealt with it; surely four pages in a book of 300 pages is a ridiculous proportion to give us in a work on the railway locomotive. All engineers are fully aware that Mr. T. W. Worsdell was the inventor of the two-cylinder compound locomotive; why Mr. James Worsdell should get the credit is a mystery. This is a careless mistake for which there is no excuse.

On the question of valve gear, expansion and link motion, we find much information, but why "James Stirling's" steam reversing gear is described as "Wainwright's" might be explained; besides this, the latest type of the Smith piston valve is not illustrated in Fig. 81. It is of the segmented type, and is intended to free the cylinder of water when necessary, being collapsible. The vacuum-destroying valve referred to has also been re-designed so far as to constitute a lubricator as well, thus lubricating the moving parts when running down hill with steam off, a much desired improvement.

We have much pleasure in noticing these two books; they have been written from such different points of view that one forms the corollary of the other. Locomotive engineers will do well to find a place for both in their libraries.

OUR BOOK SHELF.

Feste Lösungen und Isomorphismus. By Dr. Giuseppe Bruni. Pp. vi+130. (Leipzig: Akademische Verlagsgesellschaft, 1908.) Price 4 marks.

As an authority on the subject of solid solutions Dr. Bruni has an international reputation, and it must be considered a fortunate circumstance that the Chemical Society of Breslau should have invited the author to give a special lecture to its members, for it is to that incident that the book before us owes its origin.

The theory of solid solutions put forward by van 't Hoff in 1890 represents an extension of his well-known theory of liquid solutions to the solid state of aggregation. As a means of interpreting the vast number of experimental observations which have been accumulated since the date of its conception, van 't Hoff's theory has been invaluable. The author is one of its staunchest adherents, and has himself done much to uphold the theory in the face of adverse criticism.

Dr. Bruni has retained the original form of the address in the published text. The subject-matter of the lecture, which occupies eighty pages, is divided into two sections; the first deals with the mode of formation and the nature of solid solutions, the second with the connection between the crystalline form and the constitution of pairs of substances which give rise to solid solutions. Explanatory notes, experimental data relating to the observations referred to in the first part of the text, and references to original papers which are in many cases accompanied by critical abstracts, occupy the remaining fifty pages. The arrangement is a most satisfactory one, and the many references afford an excellent bibliography of the subject.

Not more than ten years ago a solid solution was regarded as somewhat in the nature of a *rara avis*. The investigations of Roozeboom, Tammann, Kurnakow, Bruni, Carelli and others have, however, necessitated a complete change in the attitude of the chemist towards the conception. As showing the general character of the phenomenon, the fact may be cited that of one hundred and forty pairs of elements examined by Tammann and his pupils, no less than seventy-seven give rise to solid solutions, and in twenty-three cases mixed crystals are formed which contain the constituent elements in all possible proportions.

Most interesting is the author's account of the application of the observed facts relating to the formation of solid solutions to the determination of the configuration of organic compounds. That much valuable information may be obtained from observations on syn-morphism (ability to form mixed crystals) in connection with the solution of certain stereochemical problems is clearly indicated. It is, however, not only on account of its applications, but of the intrinsic interest which attaches to the phenomenon that Prof. Bruni's lucid exposition of the subject of solid solutions and isomorphism may be expected to meet with a favourable reception by a wide circle of readers. Not merely the chemist, but the physicist, mineralogist, and geologist will find much that bears on his particular subject in this little volume.

H. M. D.

The Economic Open-air Chalet for the Hygienic Treatment of Consumption and other Diseases. By R. Foster Owen. Pp. 16. (London: Baillière, Tindall and Cox, 1908.) Price 1s. net.

Much attention has of late been bestowed on the open-air treatment of consumption and other tuberculous diseases, but residence in sanatoriums is expensive and only possible for the well-to-do, and the provision of shelters and homes suitable for the poor is deserving of much consideration. The booklet under review describes the construction of a cheap shelter, and the author claims that by the enlargement and multiplication of such shelters, colonies for the tuberculous poor could be founded at comparatively small cost.

The chalet described is constructed wholly of wood, is elevated 3 feet above the ground, and built upon piles of wood. If considered desirable the supports may be of brick with a foundation of old pitch and tar. The superstructure is surrounded by a veranda and approached by a flight of steps of wood. The veranda is of sufficient width to admit of a chair or lounge for the patients to sit or lie out in any weather, and is protected by a sloping, overhanging roof, which covers the whole veranda. The walls are permanently open in panels, chin height (as a rough measure), and fitted with a simple mechanism allowing of the erection of panel shutters should it at any time be found necessary. In case of severe wind, rain, snow, or of intense cold, this provision may be of service. It will, of course, only be used as the doctor-in-charge shall direct, for it must be remembered that the poor have to be taught to overcome their innate dislike to fresh air, which is only too frequently misnamed draught.

The interior of the economic chalet is divided into cubicles, with an ante-room for lavatory purposes. For patients of the working class an open ward is best, with separate washing-room and lavatory. The corners of the chalet are rounded off, and the walls perfectly smooth and washable. The roof is provided with two large dormer windows for the admission of light, at each side of chalet. The author will be pleased to supply particulars as to cost, &c.

R. T. H.

Welt-Leben-Seele. Ein System der Natürphilosophie in gemeinfasslicher Darstellung. By Max Kassowitz. Pp. iv+364. (Vienna: Verlag von Moritz Perles, 1908.) Price 5 Kr.

The author tells us in the preface that he has devoted his intervals of rest during a ten months' tour through the most beautiful countries of Europe to the production of a popular exposition of the three tremendous subjects the names of which form the title of his book. This information puts the critic at an obvious disadvantage, for he is tempted to view indulgently, and as merely the natural efflorescence of holiday spirits, the reckless demolition of respectable opinions and the amazing logical feats that characterise Dr. Kassowitz's progress through his theme. But the reader (like Quintilian) can only stare and gasp when he finds, on the seventh page from the end, that the author regards his work as an attempt to purge the scientific interpretation of nature from the "metaphysical" elements that at present clog it. It is true that by the avoidance of metaphysics he means something quite different from a restriction to positive statements about the actually observed course of phenomena, for he does not feel himself debarred from deciding on *a priori* grounds such questions as the infinite divisibility of matter and the inheritance of acquired characters.

His cardinal maxim is that an assumption or hypothesis is not to be entertained if it is not "analogous to experience," and it leads him to such arguments as the following. We never find motion apart from matter; consequently, if motion has passed over from one thing to another it must have been carried by moving matter. Again, since we know no homogeneous continuous substance, there can be none; therefore the transference of motion, even through the æther, must (from the foregoing proposition) involve the agency of an infinite series of atoms of increasingly higher order. Once more, there can be no natural selection, for this would imply somewhere a supernatural knowledge of the future usefulness of the selected variation. One would have thought that the glare of the fallacies involved in these arguments would have shone even through the delicious obfuscation of a walking tour.

Abhandlungen über theoretische Physik. By Prof. H. A. Lorentz. Vol. i., part i., pp. 298. Price 10 marks. Part ii., pp. 299–490. Price 6 marks. (Leipzig: B. G. Teubner, 1906–7.)

On December 11, 1900, Prof. Lorentz celebrated the twenty-fifth anniversary of his doctorate. His physical researches thus extend over rather more than a quarter of a century. In editing them for publication, Prof. Lorentz has aimed at bringing them into the form of a connected series, and a great many modifications and alterations have been made with the view of rendering the collection more useful in the light of recent developments. A number of papers of minor importance have been omitted and changes of notation have been freely made; instead of adopting a chronological order, the author has classified his papers according to subject-matter, and several new and hitherto unpublished results now find their way into print for the first time.

Vol. i. is divided into two parts, the first dealing with dynamics, hydrodynamics, thermodynamics, and kinetic theory—in short, molecular physics; the second with crystallography and physical optics. The following papers are now published for the first time:—Regions in n dimensional space (1905) (p. 151); the second law and its relation to molecular theory; symmetry of crystals; boundaries of crystals (all three based on Prof. Lorentz's lectures); propagation of light in an arbitrarily moving medium (not previously published); propagation of waves as rays in a non-absorbing medium (1906). The papers are now printed in the language in which they were originally published. As Prof. Lorentz points out, Dutch physicists find it necessary to publish their papers in one of the three principal international languages, and Prof. Lorentz did not consider it necessary to translate all the papers into one common language.

G. H. B.

The Wonderful House that Jack Has. A Reader in Practical Physiology and Hygiene. For use in School and Home. By Columbus N. Millard. Pp. xiii+359. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 3s.

This well-printed, well-bound, and well-arranged book adds yet another to the long list of popular physiologies. The author endeavours to convey, without difficult technicalities, all the main points of the physiology of the body—the building of it up from food materials, digestion, the stomach, milk, animal foods, food habits, breathing habits, stimulus, clothing, eyesight, hearing, rest and sleep, infectious diseases, &c. The expositions are very simple and attractive. There are many illustrations. Each chapter has a set of questions appended, and there is a glossary of terms, obviously meant for the most elementary pupils. The book may be thoroughly recommended as a good class book.

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.*]

Sequestrated Church Property.

A WIDELY spread feeling exists, especially among Roman Catholics, that sequestrated church property carries a curse with it; that the effect of the curse is to extinguish the line of descent from its owner, and to fall most heavily on the eldest son. A lady was so much impressed with what had been told her and with the evidences adduced as to the reality of the curse, that she asked me to help in investigating the matter. It had other interesting aspects, so I consented to frame an appropriate *questionnaire* for starting the inquiry on proper statistical lines. This was printed, and 245 copies of it were filled up by a well-known antiquarian, the Rev. Harvey Bloom, of Whitchurch, near Stratford-on-Avon, in the order in which they happened to be entered in the works of reference that he used. Their contents were then discussed by Mr. Edgar Schuster, fellow of New College, Oxford, and formerly research fellow of the eugenics laboratory in University College, London. Finally, such of the results as seemed most appropriate are given here. Mr. Schuster's report was elaborate; it ought (as he wrote when he sent it) to be checked as regards minute particulars if published in full, but he is quite content that the broad results given in the present paper should go forth as they stand.

The questions referred to the owner of each of the 245 properties in 1800 and to its owner at the present time, or at the latest date at which information was easily accessible; also to each of the intermediate owners in succession.

The phrase "Church property" applies to such properties as were ecclesiastic, wholly or in part, previous to the dissolution of monasteries under Henry VIII., and "Not church property" to those that were not so.

The results are as follow:—

SURVIVAL OF ELDEST SONS.

	Total number of owners	Of eldest sons among them	per cent.
Not Church Property	459	241	52·5
Church Property	464	240	51·7

LENGTH OF TENURE (EXCLUDING FIRST AND LAST ON THE LIST[1]).

	Mean length	Median length
Not Church Property	27·2 years	Between 25 and 26 years
Church Property	27·4 ,,	,, ,, ,,

Calculations were also made of the mean relative frequency of tenures in each of the eight groups:—0–9 years; 10–19; . . . 70–79 years. The lines in a diagram constructed from these ran closely alike, quite as closely as could be expected from the eight-times reduced sizes of the samples from which these means were derived. We may therefore rest satisfied that no appreciable effect is exerted by a curse supposed to thwart the inheritance of church property by eldest sons, or to shorten the tenure of its ownership.

A curious anomaly is, however, formed in the more than three-fold greater frequency with which church properties come into the market as compared with non-church properties. The facts are given in the following table:—

	Total of owners	Total of transmissions by purchase	Percentage of transmission by purchase
Not Church Property...	459	15	3·3
Church Property...	464	50	10·8

The answers to the *questionnaire* do not give sufficient material for minute examination into the reasons why church property is sold with this remarkable frequency, notwithstanding what has just been established concerning the length of its tenure. It would require a fresh and more delicate investigation to explain it. For the present, I am inclined to ascribe the anomaly to the comparative unsuitability to modern requirements of the dwelling houses, such as abbeys, &c., which frequently accompany church properties. They are nearly always built in low situations, near to fish ponds, and with bad drainage. They are therefore insalubrious, while the arrangement of the apartments is usually inconvenient in many important respects, and very costly to modify. On the other hand, the picturesqueness and romance of old buildings adds much to their market value. So it might be expected that when one of them falls into the possession of a distant relation, who has no very close associations with the place, who knows its discomforts, and probably has a residence of his own, he would be glad to sell. This is a pure speculation, but helps to show that the contents of the above table are not so provocative of a mysterious interpretation as they might otherwise be.

FRANCIS GALTON.

[1] These are excluded—the first, because the data did not give the commencement of the tenure; the last, because the owner was still living, and therefore the future close of his tenure was unknown.

The Isothermal Layer of the Atmosphere.

APART from other considerations, I think that Mr. Craig's contention (NATURE, January 7, p. 281) as to the isothermal layer is disproved by the results of theodolite observations on *ballons-sondes*. When a balloon is observed, its altitude above the horizon is in general seen to decrease, showing an increase of wind velocity with height. If Mr. Craig's supposition were true, this decrease in apparent altitude would become still more marked when the balloon had reached such a height that it no longer ascended; but the contrary is the case. In nearly all the ascents in which I have observed balloons for a considerable time the angular altitude, after decreasing, commences to increase again; on Mr. Craig's supposition this would mean that the balloon, after it reaches the floating condition, enters a current of air that brings it nearer to the observer, and for this to occur frequently is extremely unlikely.

Two instances will illustrate this point. A balloon on October 1 last year was watched until it burst; the meteorograph gave a height of 19 kilometres, with the isothermal layer at 12·2 kilometres. If the balloon had ceased to rise at 12·2 kilometres the observed altitudes show that it would have been moving towards the observer at the rate of 25 kilometres an hour during the six minutes previous to bursting, whereas before this it would have been moving away at the rate of about 70 kilometres an hour. At the time it burst it would have been 46 kilometres away, and it fell 104 kilometres from the starting point; the balloon was unlikely to travel further during the descent than during the ascent.

In the ascent of October 2 the balloon was also seen to burst; the height from the meteorograph was 17 kilometres, with the isothermal layer at 14·6 kilometres; if the balloon had ceased to rise at 14·6 kilometres it would have been moving towards the observer at the rate of about 9 kilometres per hour during the seven minutes before bursting, while previously it would have been moving away at the rate of about 50 kilometres per hour. If either balloon had reached a floating condition, it is difficult to see why it should have burst; it would probably have floated until loss of gas caused it gradually to descend. I think it is quite evident that on these two occasions the balloon was ascending up to the time of bursting, and both traces show the isothermal condition. If it is assumed that the height as given by the meteorograph trace is fairly accurate, the increase in angular altitude at the end of the ascent would show that the balloon had entered a layer of the atmosphere where the wind velocity had decreased considerably, which is exactly what one would expect to find in the isothermal layer.

In reference to Mr. Craig's supposition that the gas inside the balloon may be sluggish in acquiring the low temperature of the air into which it rises, it seems probable that the gas inside the balloon will tend to be at a lower temperature than the air outside, for the gas inside will tend to cool at about the adiabatic rate for dry air, while the rate of decrease of temperature of the air up to 12 kilometres or so is nearer the adiabatic rate for saturated air.

CHARLES J. P. CAVE.

Ditcham Park, Petersfield.

Magnesium in Water and Rocks.

THE recent publication of analyses of salt in the pans in Cape Colony by Dr. Juritz (*Agricultural Journal*, November, 1908, Cape Town) brings to a head a problem which has been puzzling me for a long time. A large amount of magnesia is dissolved in water on the decay of rocks, yet a very small portion finds its way to the sea. Dead coral reefs become dolomitised, but, as a general rule, recent limestone deposits do not contain more than 1 per cent. of magnesia; the magnesia dissolved in sea-water, therefore, is the accumulation of long ages, and should bear some relation in quantity to that of sodium, yet magnesium in the salts of sea-water is less than one-twelfth that of sodium. In the up-country pans in Cape Colony which collect the water washing over dolerite hills and evaporate the contents on their shallow surfaces, we find plenty of magnesia in the liquors, but practically none in the crystallised product. Here are Dr. Juritz's figures for an average sample:—

Locality	Water, grains per gallon	Salt, per cent.	
Varsch Vley	1204·0 ...	2·13 ...	Lime sulphate
(Ground salt)	Nil ...	Nil ...	Lime chloride
	553·0 ...	0·33 ...	Magnesium sulphate
	658·0 ...	1·16 ...	Magnesium chloride
	Nil ...	Nil ...	Sodium sulphate
	22050·0 ...	96·43 ...	Sodium chloride
	70·0 ...	Nil ...	Potassium chloride

Of the seventy-three samples of salt analysed, all tell the same tale; one from Belmont Salt Pan, near Kimberley, contains 7·59 per cent. magnesium sulphate, two contain more than 1·5 per cent., and the rest 1·5 per cent. or under. The ground water, however, struck in wells, is often entirely undrinkable with Epsom salts.

Magnesia compounds, on the other hand, are constantly being drawn down in the earth's crust by the descending surface waters, and cause dolomitisation. The older the limestone, generally speaking, the more it is dolomitised; joints and bedding planes in limestone are dolomitised when the rest is pure limestone, as in the "dunstone" selvages along joints in the Carboniferous Limestone of Durham and Northumberland. Why do the magnesia compounds go downwards and not outwards as the salts of lime and soda do?

The same happens with solutions of iron; practically none reaches the sea, but large amounts descend and replace limestone by spathic iron or hæmatite. In this case one would conclude that the earth's magnetic nucleus exerted a pull on the free iron in solution, which, ceaselessly acting, tended to impoverish the surface of iron. Is there some such action going on with regard to magnesia? Taking Farrington's suggestion that the average composition of meteorites represents the average composition of the earth, then the nucleus should contain a very large proportion of magnesium. Is there any evidence for an attraction of magnesium for magnesium when magnetised as there is in the case of iron for iron?

ERNEST H. L. SCHWARZ.

Rhodes University College, Grahamstown, Cape of Good Hope, December 21, 1908.

Phosphorescence on a Scottish Loch.

A REMARKABLE illumination was observed about eight years ago on a certain part of Loch Bulig (which lies in the north-western boundary of Aberdeenshire). As it appears to be the only known occurrence of phosphorescence on a Scottish loch, your readers may be interested in it. It appeared in the form of innumerable brilliant lights, shooting rapidly on the surface of the water, but many leaping one or two feet above it. It lasted for about a minute, and was repeated twice at intervals of about ten minutes. The effect was very striking, the brilliance being almost dazzling. It seemed that it could not be accounted for in any other way than by phosphorescent animalculæ, disturbed probably by a shoal of fish which are known to inhabit the loch.

Inquiry elicited the information that near where the lights were seen a soft bank stretched out from the side towards the centre of the loch. I have been desirous since that time to gather some of the deposit, if possible, for examination, but only a few months ago was I able to carry out my intention. I found it was a matter of no little difficulty, as the loch at that part is about 25 feet deep, and though it is usually quite smooth it sometimes is somewhat rough. The first attempt was a failure, the day being squally, the waves 2 or 3 feet high, and the strong wind and current rendered it difficult to locate the bank and collect specimens. The second attempt, however, was successful, and I found that the bottom was generally stony, but gave place to soft material just above where the lights had been seen. I collected two quantities of the deposit, and found that it consisted of sand mixed with a large quantity of carbonaceous matter, mostly in the form of small rolls, half an inch to one inch long. Microscopic examination showed that these rolls contained animals encased like tubicolous annelids; they were quite active, emerging from the tube, grasping black particles, and then retreating; some were encased in parchment-like tubes, through which the rapid actions of the animal could be distinctly seen; one was found with a transparent tunic, hanging by a ring from the neck, resembling *Oxyethira costalis* (Hydrophilideæ); I still have this specimen. Along with these and other animals were numerous diatoms, nematodes, &c. As some of these animals belong to classes which are known to be phosphorescent, it seems that their presence in the deposit is sufficient to account for the remarkable appearance seen. This was confirmed by finding that the sand contained much more phosphate than sand usually contains; also, by testing with ammonium molybdate some of the black matter, including one of the black rolls containing an animal, after a few hours a distinct yellow precipitate was found, but only in the vicinity of the black roll.

I should think that this deposit would form an interesting preserve for zoologists, and therefore I relate the circumstance, and shall be glad to give any further information to anyone who may desire it.

THOS. JAMIESON.

Chemical Laboratory, 10 Belmont Street, Aberdeen.

[IT is to be hoped that Mr. Jamieson will re-observe the interesting phenomenon he saw on Loch Bulig and collect material *at the time*. If he saw numerous luminescent organisms leaping in the air, they may *possibly* have been Chironomids with phosphorescent bacteria. He gives no convincing evidence in his letter that the organisms collected from the deposit were connected with the "phosphorescent" display. We may recall the fact that a "phosphorescent" Enchytræid has been reported in Britain.—ED. NATURE.]

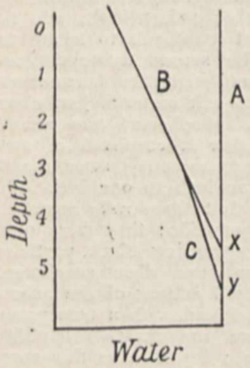
The Movement of Water in Soils.

IN NATURE of August 6, 1908, Dr. Russell refers, in his note on *soil moisture*, to some information on this subject which I published in Memoir No. 6 (Chemical Series) of the Department of Agriculture in India, and says, "Dr. Leather argues that water moves upwards from a limited depth only. . . . The results are equally well explained on the supposition that the upward movement takes place at all depths, since the amount of water present in a particular layer depends on the respective rates at which water is gained from below and lost to the upper layers."

I still maintain that the process of upward movement of water through a soil during dry weather is one which is not brought into operation throughout all strata of a soil instantaneously, but that, on the contrary, time is required for it to be communicated through succeeding strata; consequently, during a dry period there will be strata in which the process has not yet become established. Until an alteration of the surface tension occurs in any stratum there can be no movement (due to this cause) of water, and a *necessary* result of the fact that this alteration of surface tension through succeeding strata is *gradual* is that any such alteration *must* be accompanied by a decrease of water per cubic foot.

A second consequence is that if the total decrease of water which occurs during a dry period throughout the strata is ascertained, this will be precisely that quantity of water which has evaporated from the surface of the land.

The only weakness that I have been able to perceive in the conclusions which I drew in 1907 regarding this matter is the exact depth which was affected. This I concluded to be 7 feet in the Pusa soil. As a matter of fact, the ascertainment of this depth with exactitude is not possible. In the marginally shown diagram are three curves. A represents the water immediately after rain ceases (in an ideal physically uniform soil). B represents the water as ascertained at the conclusion of the dry period, and cuts A at the point x, below which no decrease of water has been perceptible by the methods employed. Owing, however, to errors, due principally to difference of physical character of soil, this point cannot be determined exactly, and in reality the curve might be BC, that is, it might cut A at, say, y, and not at x; but the difference between the ascertained loss and the real loss can only be trifling. It is perhaps needless to add that this error does not affect the principles involved. It is naturally assumed that the points x and y are above the stratum of soil which is maintained in a saturated condition by the underground water.



J. WALTER LEATHER.

Pusa, Bengal, November 23, 1908.

DR. LEATHER is no doubt correct in supposing that the upward movement of water through the soil is gradual, and in his further deduction that there must, for a time, be some strata in which the water has not yet begun to move; but we do not know the velocity at which water travels upwards in the soil, and consequently one cannot say whether the time during which any particular stratum remains unaffected is to be measured in days or months. Dr. Leather's results do not give the velocity of upward movement, but the difference between the loss and the gain of water at different depths. It is no more possible to calculate the amount of water that has passed through a particular stratum by determining the amounts present at two different times than it would be to calculate the quantity of heat passing along a rod of unknown thermal properties by measuring the temperature change at a particular point.

The great value of Dr. Leather's results lies in the fact that they are the most complete set of moisture determinations yet made under conditions of drought. If only some physicist could be induced to turn his attention to soil problems he would find these *data* very useful.

E. J. RUSSELL.

The Rothamsted Laboratories, Harpenden, Herts.

The Correlation of Teaching.

THE valuable summary of Prof. Perry's address to the "correlation" conference given in NATURE of December 3, 1908 (p. 143), contains the following statement:—"If a boy wrote a description of anything he had done in a laboratory or elsewhere, it should be an exercise in English." This is, *unfortunately*, accepted by educationists at the present time. Can Prof. Perry not aid in breaking down this barrier to progress rather than in fixing its joints more firmly? He has done so much, cannot he do more?

I would suggest, whether in class-room exercises or in examinations, that the boy's resultant essay should be examined and corrected by the examiner without reference to spelling, writing, grammar, &c. The object should surely be to put on paper what has been learnt about the subject in hand. Spelling being the result of the use of accurate vision, writing being the result of physical and nervous stability, need in no circumstances affect the value of a scientific production. As the boy gets older and as his view of life extends, the value of his production, from the point of view of English, will gradually improve.

Besides, it is nothing short of an absurdity to look at certain exercise books, where the red-ink corrections, that have taken so much of the teacher's time, are chiefly connected with something that in no way affects the value of the exercise itself.

CHARLIE WOODS.

December 31, 1908.

I AGREE with Mr. Woods in his condemnation of a system in which every exercise is treated as if grammar and composition were as important as the subject-matter; but surely he is going too far when he says that in writing a description of what he has done or seen, a boy need not fear that his grammar or spelling or composition will be criticised at all. I ask the science master, in teaching science, to teach also mathematics and English and sketching incidentally, and to take some pleasure in doing it. If he insists that these subjects are the absolute preserves of the mathematical, the English, and the drawing masters, he must not be astonished when a classical master openly expresses pride in an ignorance of "stinks."

I do not think that the system which Mr. Woods condemns is very much in vogue, whereas the system of which he approves has done an immense amount of harm. We all of us know men holding the highest science degrees whose spelling, grammar, and composition are beneath the contempt of a board-school boy. In nine cases out of ten it will be found that when a student cannot give a clear account of what he has seen or done, he has no clear ideas about the matter, and every examiner knows that it is only the very exceptional man who has clear knowledge yet cannot express himself clearly. If the examiner has a keen sense of justice this candidate gives him more trouble than any five others.

JOHN PERRY.

An Electromagnetic Problem.

THE problem noticed by Mr. Comstock in NATURE of November 19, 1908, is an interesting one, but I do not see how the "laws of electricity and conservation of energy require in themselves the discrete structure of electricity or the association of electricity with matter." The electromagnetic field produced by a uniform spherical sheet of electricity, unassociated with matter expanding under its own repulsion, is not zero, but indeterminate. The total energy of the system remains finite and constant, while the velocity of expansion is that of light. Thus perfect uniformity of electricity, together with isolation, is not incompatible with the laws of electricity and conservation of energy. The indeterminateness of the electromagnetic field will, of course, surprise no one who is willing to start with a distribution of electricity differing infinitely little from that of perfect uniformity, arranged as a sheet differing infinitely little from spherical, and expanding in surroundings departing infinitely little from the symmetrical.

A. CORE.

MR. CORE's objection would apply in many problems where certain functions appear to vanish because of symmetry, but in the present case I think it does not apply.

In physical problems it is well to avoid mathematical "sheets" except in unusually simple circumstances, and in the present case the spherical shell of electricity which is expanding under the mutual repulsion of its parts is to be considered of *finite thickness* and of constant volume density of electricity.

In these circumstances the displacement current is evidently equal and opposite to the convection current when the sphere is expanding, and hence the curl of the magnetic force is zero everywhere. This requires the magnetic force to be zero everywhere, since such a vector vanishing at infinity and having its curl and divergence both zero must itself vanish. It is not then immediately evident what becomes of the electrical energy lost on expansion.

D. F. COMSTOCK.

Institute of Technology, Boston, December 17, 1908.

THE ANTHROPOLOGY OF THE GREENLAND ESKIMO.[1]

THIS work deals in a very thorough fashion with the psychology and culture of the three distinct branches of the Eskimos which make up the population of Greenland, namely, the West Greenlanders, the East Greenlanders and the Polar Eskimos. The book is splendidly illustrated by Count Harald Moltke.

The greater part of the book is devoted to a description of the Polar Eskimos, who live on the strip of land north of Cape York, and are the most northerly people in the world. Mr. Rasmussen, who was born in Greenland, appears to have thoroughly understood the people and how to gain their confidence. The consequence is that during his ten months' residence among them he has been able to collect a vast amount of interesting information about their daily life, their beliefs about the origin of the universe, and their fables and legends.

Even the Polar Eskimos, though the least advanced of the three groups of Greenlanders, appear to have progressed well beyond the stage of primitive savagery; they have fully entered the magical stage and to some extent passed into the supernatural. The magician is a man of mighty power amongst them. Their religious beliefs consist of a series of commandments and rules of conduct controlling their relations with unknown forces hostile to man. The magician makes these powers subservient to himself. He has developed his faculties so that he can put himself in communication with the spirits. He uses a special spirit language in his incantations. Magic is said, however, to be degenerating among these Eskimos, because they are not nowadays much exposed to danger.

Some of their beliefs that have apparently been handed down by oral tradition through untold generations are by no means primitive, and have a remarkable resemblance to the beliefs of some peoples in a much more advanced stage of civilisation. The Polar Eskimo believes that every person has a soul, a body and a name. He believes that the soul is immortal, that when the soul leaves the body the body dies, and that on the death of the body the soul ascends into heaven. It is believed that the soul of a man, on his death, may pass into one of the lower animals; the doctrine of the transmigration of souls appears, in fact, to be fully developed among the Eskimos.

The body of the Eskimo at death is buried by his relatives along with all his implements, and his dogs are slain harnessed to a sledge which is placed by his grave. For a woman only one dog is slain.

The name was originally believed by the Eskimo to be a kind of soul, which transferred the qualities of a dead person to the living person who received the name.

As regards the personal character of the Polar Eskimo, he appears to take a very practical view of life. The boys learn the main business of life, namely, hunting, in their play, and abstract reflection appears to be unknown. They are very fond of their dogs; one has been known to attack a bear at great personal risk in order to avenge the death of a favourite dog.

Polygamy is rare among them, but there survives a curious custom of exchanging wives which appears to have the full sanction of public opinion.

A very complete collection of the fables and legends of this interesting people will be found in Mr. Rasmussen's volume. These were all collected from the natives by the author, and great care, apparently, was taken to get the correct versions. This material will be invaluable to the folklorists. But whether they will be of much value, as suggested by Mr. Herring, in tracing the racial origin of the people is doubtful, for very close analogies to some of these tales will be found in the lore of the most distant parts of the earth. For example, the tale of the man who married the goose by stealing her coat of feathers, which she had laid off while bathing, is paralleled by a very similar tale in the "Arabian Nights."

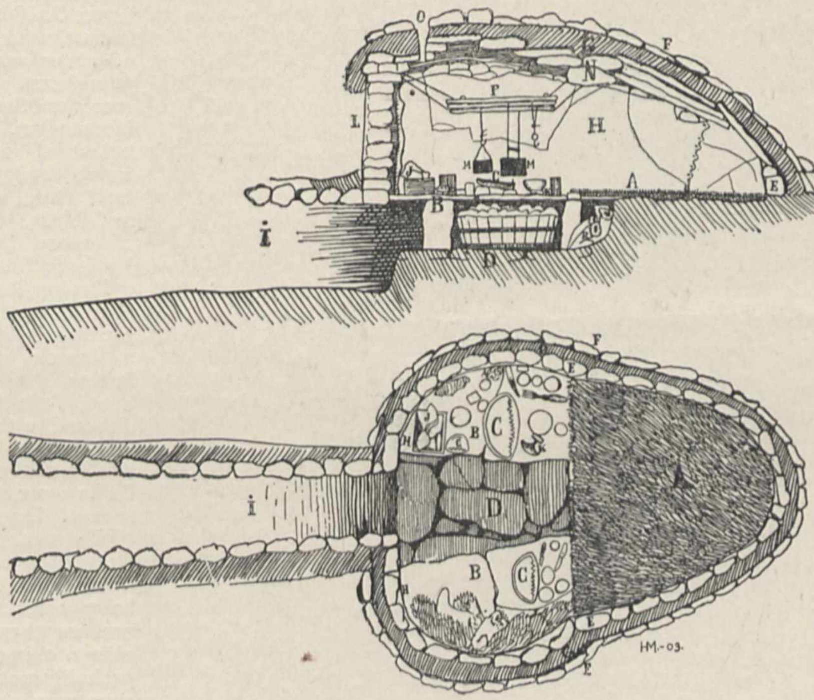


FIG. 1.—Elevation and Plan of an Eskimo Hut. From "The People of the Polar North."

Very little information about the physical characteristics of the Eskimos is given in this book, except what can be derived from the excellent representations of typical natives by Count Harald Moltke. The faces of the Polar Eskimos appear to be decidedly mongoloid. But all measurements of Eskimos hitherto made show that they have a very low cephalic index, not higher than 77, and in some groups as low as 73. This would appear to point to a cross between a mongoloid and some dolichoçephalic race, such as was

[1] "The People of the Polar North." By Knud Rasmussen. Compiled from the Danish originals and edited by G. Herring. Illustrations by Count Harald Moltke. Pp. xix+358. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1908.) Price £1 1s. net.

to be found in Neolithic times in north-western Europe.

The portraits of the West Greenland type show that they approximate much more closely to the European type. These people live much further south, on the tracts of land left between the margin of the great Greenland glacier and the west coast. The West Greenlanders appear to have abundant supplies of food, obtained by hunting and fishing, walrus, seal, halibut, and salmon in the greatest abundance being readily obtainable by the active native. They are very hospitable and superstitious, the latter trait, according to the author, being due to the influence of the long winter night.

The East Greenlanders have now mostly migrated from the east coast to West Greenland. Apparently, before they moved, owing to their isolation they had reverted to a state of savagery and developed a kind of murderous mania which led to the most terrible tragedies. Now, when living amongst the West Greenlanders, they appear to have greatly advanced under the influence of the Danish missionaries.

The map attached to the volume would be of much greater value if it contained more of the places referred to in the text.

This book, however, will take a high place as a study of the characteristics of an extremely interesting and fast vanishing people by a competent and sympathetic observer.

FIG. 2.—Greenlandic Woman from Kangeq, near Godthaab. From "The People of the Polar North."

A HUMAN FOSSIL FROM THE DORDOGNE VALLEY.[1]

THE curtain which conceals the early history of our race is being in these last years lifted at frequent intervals to afford us glimpses into the distant past. Among the latest revelations are those by the Swiss explorer, M. Hauser, of a nearly complete human skeleton—not yet fully described—from a rock-shelter in the Vézère Valley, chinless, with the great orbits and retreating forehead characteristic of the Neanderthal type; and those still more recently made by the well-known prehistorians the Abbés J. and A. Bouyssonie and M. L. Bardon during their excavation of a cave opening in the vale of a small tributary of the Dordogne river, in the commune of La Chapelle-aux-Saints, in the Corrèze. Their careful and scientifically conducted excavations had previously, in 1905, been rewarded by the discovery of numerous quartz and jasperoid flint implements, scrapers (*racloirs*) and lance-heads (*pointes*), with others rather better finished and suggestive of the Aurignacian, which, taken with the entire absence of ruder amygdaloid implements (*coups de poing*) and of all worked bone, fixes with precision the archæological horizon as Late Mousterian. The fauna associated with these industrial relics includes reindeer, horse (rare), badger, woolly rhinoceros, marmot, wolf, fox, sheep or goat, a large bovine, and birds, and is characteristic of the cold climate of that epoch, which corresponds, in geological terms, to the Middle Pleistocene.

During last autumn the same three archæologists resumed their investigations, with the result that on August 3, while digging a trench in the cave, they uncovered a human skeleton, lying on its back, with the head, which was protected by stones, directed to the east. The right arm was bent so that the hand lay towards the body, the left arm was slightly extended, and the limbs were drawn up. Above the head were several large fragments of bone laid flat, while near by was placed the terminal phalanges of the hind hoof, with several of its associated bones, of a large bovine. The body was, therefore, intentionally buried, and as there is an entire absence of fire-places it is concluded by the excavators, but probably not with universal accord, that the cave was not used as a dwelling, but only as a burying-place, where the abundance of bones and implements indicate only the holding of numerous funeral-feasts.

These human remains, which are of the greatest anthropological importance and interest, have been described by M. Marcellin Boule, the distinguished palæontologist, in a preliminary note read on December 14 last before the French Academy of Sciences, and published in the *Comptes rendus* of the academy cited below. The bones comprise a much broken cranium and mandible, vertebræ and limb-bones of a man of 1·60m. (a little more than 5 feet 2 inches) in stature. As the edges of the cranial fragments were unworn, it was possible to piece them very accurately together. The

[1] "L'Homme fossile de la Chapelle-aux-Saints (Corrèze)." Note de M. Marcellin Boule (*Comptes rendus de l'Académie des Sciences*, t. cxlvii., No. 24, December 14, 1908).

"Découverte d'un squelette Humain mousterien à La Chapelle-aux-Saints (Corrèze)." Note de MM. A. and J. Bouyssonie et L. Bardon (*Comptes rendus*, t. cxlvii., No. 25, December 21, 1908).

cranium, from the state of its sutures and its dentition that of an aged male, is remarkable for its size in comparison with the short stature of its owner, and for its simian or pithecoid characters. The skull is dolichocephalous (index 75), and remarkable for its thick bones, its flattened cranial vault, enormous brow-ridges (which are more prominent than in the original Neanderthal cranium), with a deep groove above them stretching from one orbital process to the other, for its much depressed occipital "bulging," for the backward position of the *foramen magnum,* the flattening of the occipital condyles, and the feeble development of the mastoid processes. The very prognathous face has large and prominent orbits, with a deep depression between them separating the short and very broad nose from the forehead. The upper maxillary differs widely from that in all living races of mankind, in projecting in front, into a sort of muzzle; while the palatine contour is very simian. The lower jaw is remarkable for its massiveness, the great width of its condyle, the shallowness of its sigmoid notch, the obliquity of its symphysis, and the absence of chin.

The La Chapelle-aux-Saints cranium, therefore, presents the characters, in some respects exaggerated, which distinguish the Neanderthal and Spy calvaria, all of which, though widely spread over Europe, but on about the same geological horizon, certainly belong, in M. Boule's opinion, to one type. Its mandible also presents the characters of the fossil mandibles, of the same age, known as Naulette, Spy, and Malarnaud. In the same palæontologist's estimation, the Neanderthal type should be considered a normal human type, characteristic of certain parts of Europe in the Middle Pleistocene. This type is different from, and lower than, any now living, for in no existing race are to be found united the low characters seen in the La Chapelle-aux-Saints cranium.

M. Boule, however, is not prepared to separate the Neanderthal-Spy–La Chapelle-aux-Saints group *generically,* but he would not hesitate to distinguish the La Chapelle-au-Saints man *specifically* from those of all other human groups, living or fossil. He considers it certain that the Neanderthal-Spy–La Chapelle-aux-Saints group represents a low type, nearer to the anthropoid apes than to any human group, and morphologically he would place them between Pithecanthropus and the lowest living races, yet without implying that they are in the same genetic line. The men of the Middle Pleistocene, judged by their physical characters and the relics of their industry, were in a primitive condition intellectually; while those who lived during the Upper Pleistocene possessed mental powers of a much higher order and were capable of producing true works of art, and their crania acquired the principal characters—the fine forehead, large brain, heaven-surveying countenance—of *Homo sapiens.*

A special interest attaches to the description given above of this new type of Homo, when we recall the various drawings of supposed "humans" left us by the men of the Upper Pleistocene on reindeer horn, ivory, and fragments of schist. These artists have depicted for us an extensive zoological picture-gallery, with a fidelity to nature hardly to be surpassed by any present-day artist. Their sketches are all from subjects with which they were intimately acquainted, and if there be forms among them which so far have not been recognised by us, we may rest assured that they were also reproduced from actual models. Among the palæolithic engravings much criticised are those of various anthropoid forms—such as the two accompanying examples (Figs. 1 and 2) from M. Piette and MM. Cartailhac and Breuil—which some ethnologists have hesitated to recognise as human, because of their pronounced simian characters. The description given above of the man of La Chapelle-aux-Saints seems to fit, in his snout-like jaws, semi-erect attitude, gibbon-like nose (especially Fig. 2), with wonderful exactitude, the drawings preserved to us at Mas d'Azil and elsewhere. Two very interesting questions suggest themselves: Are these pictures of a race surviving from the Middle Pleistocene? and, Were the artists of the Reindeer age depicting individuals of their own race? The present writer is convinced, and has long held, that they certainly depicted people contemporaneous with themselves, and reproduced them

FIG. 1.

FIG. 2.

as accurately as they did the bisons, horses, and rhinoceroses amid which they lived.

H. O. F.

BLACK-WATER FEVER.[1]

WE have before us a very careful and detailed study of one of the most dangerous of tropical diseases, which has numbered many victims amongst Europeans of all ranks and classes in various parts of the world; the public that reads NATURE will not need to be reminded of the sad death of that distinguished zoologist, Mr. J. S. Budgett, from black-water consequent on malaria contracted during his collecting expeditions in Africa.

The authors are especially concerned with the question of the nature and origin of black-water fever; the prophylaxis and treatment of the disease are dealt with very briefly. After a historical introduction the etiology of black-water fever is discussed and narrowed down to two alternative hypotheses, (1) that the disease is due to a specific organism, (2) that it is of malarial origin. It is then shown that the disease is not due to any parasite visible to critical microscopical examination, and that "the trend of evidence is steadily in favour of a malarial, as against a specific, origin." Facts are brought forward to show that in black-water fever the process of blood-destruction is what the authors propose to call "lysæmia," namely, "that condition, in which the red cells undergo solution in the plasma, and in which

1 "Black-water Fever." By S. R. Christophers and C. A. Bentley. Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India, No. 35. Pp. iv+239.

results true hæmoglobinæmia followed by hæmoglobinuria." Parasitic, osmotic, and chemical actions having been excluded as causes, it seems to the authors "most probable that black-water fever is due to some specific hæmolysin arising within the body" as the result of certain conditions, induced by repeated attacks or infections by malaria. The hæmolysin is believed not to be derived from the malarial parasites themselves, but to be thrown out by the cells of the body in response to stimulation, as a result of the constant phagocytosis of red cells. "If hæmolysins are formed against the blood there seems no agent so likely to effect this as the endothelium." The prophylaxis of black-water fever is "simply the prevention, as far as possible, of malarial infection, and the prompt and efficient treatment of this disease." In the palliative treatment of black-water fever the authors wish to show that "there are excellent reasons for believing that good results may be expected from serum-therapy."

The Government of India is greatly to be congratulated on the enlightened manner in which it aids forward the production, and undertakes the publication, of important and valuable investigations of this kind.

ANIMATED PHOTOGRAPHS IN NATURAL COLOURS.

THE production of photographs in colour by means that may fairly be described as photographic is now quite common. Though the simple method of getting pigmentary colours in the picture by the direct impact of the coloured lights proceeding from the object has not been, and may never be, realised, except, perhaps, to a certain extent by very prolonged exposures, the indirect three-colour process in its numerous modifications has thoroughly established itself as a quite practical method. It is natural, therefore, that endeavours to get kinematograph views shown on the sheet in natural colours should follow on the same lines that have made such great successes possible in single photographs.

Three-colour projection involves the taking of three negatives and the making from these of three suitably coloured positive transparencies which may then be superposed to form a single coloured transparency, or, using suitable colours, projected by three lanterns separately upon the screen and superposed there. The latter method would obviously commend itself in kinematography, because of the difficulty, if not the impossibility, of uniting three long strips into one, maintaining correct superposition from one end to the other. Besides, three lanterns would obviously give a good illumination on the screen more readily than one lantern. Many attempts, or at least suggestions, for it is difficult to know whether a verbal description really means anything more, have been made in this direction. Mr. G. Albert Smith, in a lecture recently given at the Royal Society of Arts, described the difficulties he met with in a really practical and persevering attempt, in conjunction with Mr. Charles Urban, to succeed on these lines. There was not only the difficulty of photographing with the necessarily short exposure through the red screen, which was eventually overcome, but the practical impossibility of getting correct, or even passably correct, registration of the three pictures on the screen. This is a very different problem in kinematography from the production of a single three-colour picture. Obviously the three series of photographs must be taken simultaneously, and although the three kinematograph cameras may be synchronised, as they are necessarily somewhat bulky, the three points of view must be separated, and this introduces differences in the pictures analogous to the differences between the individuals of a stereoscopic pair. But this is not the only difficulty. It is comparatively easy to get three pictures on the screen from three lanterns or a triple lantern correctly superposed when the lanterns are quite still; but it is a very different matter in the case of kinematograph projection apparatus, for here the film runs through it in a series of rapid jerks, and the slightest movement of the apparatus produces a very much increased effect on the screen, because of the very considerable magnification necessary. Mr. Albert Smith describes the result of his best attempts as "unbearable confusion."

All the mechanical difficulties of registration, and the dissimilarity of the photographs taken from three points of view, are done away with by using one film only and allowing the three coloured images to alternate. This has, further, the very great advantage of simplification, for the apparatus for taking and projecting is single only instead of three-fold. Of course, the film must pass more quickly through the apparatus, as it requires three pictures to form the single complete impression instead of one. The difficulties of this are obvious in a general sense, and it also means a shortening of the exposure time in taking the pictures, a disadvantage especially with the red and green screens. Still, the method was successful, but Mr. Albert Smith found the colours to be "washy and ineffective." It is not obvious why this must needs be so; probably the defect might have been remedied, but Mr. Smith applied himself to further simplification, and aimed, in spite of theory, at reducing the colour records to two. In this he has been surprisingly successful, as his demonstrations show. It is not easy to follow his reasoning as to the most suitable colours, but as a matter of fact it seems that he uses a red inclining to orange and a green inclining to blue. The two colour screens are on a disc that rotates in front of the lens so that each alternate picture is taken and afterwards projected through the one colour. Thus the ordinary apparatus is available by the addition of the rotating disc that carries the colour screens, there is no difficulty with regard to registration, and the increase in speed of working, as compared with the ordinary kinematography, is doubled only instead of tripled. Doubtless there are imperfections in the colours, but the same may be said of all three-colour work. It has, however, been demonstrated that greys are fairly well reproduced, and that there are no striking errors even in such compound colours as purples. A comparison of the results so obtained with an autochrome slide made of the same view shows practically no difference to the ordinary observer. We may therefore say that Mr. Albert Smith's method is not only very good as a first step towards kinematography in colours, but that it is a really practical method.

PROF. H. G. SEELEY, F.R.S.

THE death of Prof. H. G. Seeley, which took place at his residence on the morning of January 8, makes a big gap in the ranks of the comparatively small body of British vertebrate palæontologists, among whom the deceased professor was entitled to rank as the *doyen*. Born in London in February, 1839, he seems to have acquired literary and scientific tastes at an early age, and in the 'sixties we find him established at Cambridge, where he was taken up by the late Prof. Adam Sedgwick, and employed to work at the fossil vertebrates then being rapidly accumulated in the Woodwardian Museum, and likewise to lecture on geology when the aged professor was incapacitated from doing so by infirmity or illness. It was at this time that the so-called coprolite diggings were in full swing in the neighbourhood of Cambridge, and Seeley was to the fore in bringing to light what was to a great extent a new Mesozoic vertebrate fauna, albeit one of which the remains were for the most part in a sadly fragmentary condition.

This was, in fact, the first of Seeley's two great opportunities in this field of research, and he undoubtedly made the most of it, for it is to him that we owe the first discovery of birds in Cretaceous strata—birds which, as Prof. Marsh subsequently showed, retain evidence of reptilian affinity in the possession of a full series of teeth. Much information was likewise acquired at the same time in regard to the structure of pterodactyles, of which numerous remains were obtained in the coprolite workings. The results of these studies were published in a somewhat bald form in a preliminary "index" to the remains of Mesozoic birds and reptiles in the Cambridge Museum.

Although entered as a student at Sidney Sussex College, Seeley never took a degree, and soon after Sedgwick's death he left Cambridge for London, where in 1876 he was appointed to the chair of geography at King's College. In the same year he was chosen professor of geography and geology at Queen's College, London, while five years later he was appointed dean of the college. In 1890 he commenced lecturing on mineralogy and geology at the Royal Indian Engineering College at Coopers Hill, and a year later was appointed to fill the post previously held by Prof. Martin Duncan. Finally, in 1896, he became professor of geology and mineralogy at King's College. As if all this was not work enough for any man, he likewise conducted for many years the excursions of the London geological field class.

In 1862 Prof. Seeley was elected a Fellow of the Geological Society, and in 1879 he was admitted to the fellowship of the Royal Society, while in 1905 a fellowship at King's College was awarded him. He served on more than one occasion on the council of the Geological Society, from which body he also received a medal. The honorary memberships of foreign scientific bodies accorded in honour of his labours are too numerous to mention on this occasion.

The second great opportunity in his career came in 1889, when, under the auspices of the Royal Society, Seeley started for South Africa in order to collect and study the remains of the marvellous anomodont reptiles which render that country of such intense interest to the palæontologist. On his return, he spent a large amount of time and labour on working out his collections, many of the results of these studies being published by the Royal Society in its Transactions. As each section of the work was completed, such specimens as were his own property were presented to the natural history branch of the British Museum, where they form some of the most prized treasures of the fossil reptile gallery.

In this investigation Prof. Seeley definitely recognised the intimate relationships existing between the anomodont reptiles and the lower mammals, a matter on which previous writers had displayed some degree of hesitation and wavering. If he had done nothing else, his claims to a high place in the records of palæontology would have been fully established by the recognition of this one great fact. For the trend of all subsequent work has been to emphasise the intimacy of this relation between mammals and the anomodonts.

In several respects Prof. Seeley was unlike other men, so that his work can scarcely be judged by the ordinary standards, and the time for a final judgment has not yet arrived. That palæontological (to say nothing of geological) science has lost a student with an almost superhuman store of knowledge is, however, admitted by all. R. L.

NOTES.

ON December 31, 1908, Mr. H. B. Woodward, F.R.S., retired from the Geological Survey of Great Britain, after more than forty years' service. His post as assistant to the director has been taken by Dr. A. Strahan, F.R.S., and the vacancy in the district geologists thus created has been filled by the promotion of Mr. George Barrow.

A POLL has been taken of the proprietors of the London Institution in connection with the proposal to amalgamate the institution with the Royal Society of Arts. The result shows that the majority of the proprietors are in favour of the scheme for the amalgamation of the two societies. A meeting of the board of management of the London Institution is therefore being held as we go to press to consider the next step to be taken.

PROF. J. ARTHUR THOMSON, of Aberdeen University, has been invited by the lecture committee of the South African Association for the Advancement of Science to give the "South African Lectures" for 1909. The lectures are to be delivered in August and September in Johannesburg, Pretoria, Bloemfontein, Kimberley, Cape Town, Grahamstown, and Durban, and at the request of the committee they will have special reference to the Darwin centenary. The previous lecturers were Prof. Raleigh, Magdalen College, Oxford, and Mr. Herbert Fisher, New College, Oxford.

THE Paris correspondent of the *Times* reports that on January 6 the driver of the Côte d'Azur express was attacked by an eagle while the train was proceeding from Chalon sur Saône to Fontaines station. The bird, which measured 2 metres across the wings, flew into the cab of the engine, and was only overcome after a severe struggle.

WE regret to notice in *Science* the announcement of the death on December 19, 1908, at the age of fifty-eight years, of Prof. Thomas Gray, professor of dynamics and engineering at the Rose Polytechnic Institute, and distinguished for his work in these subjects.

WE regret to see the announcement of the death, on December 25, 1908, of Major Percy B. Molesworth, R.E., in the forty-second year of his age. He died at Trincomali, Ceylon, where he had been stationed for some years. Major Molesworth was one of the most careful and assiduous of planetary observers, especially of Jupiter and Mars. He published in the Monthly Notices of the Royal Astronomical Society a long series of observations of Jupiter made in 1903–4, and recorded what appears to be a unique instance of perceptible change on the planet's surface in the course of a few minutes. He made a series of observations, amounting to many thousands, of transits of spots on the planet, the results of which were published in the Memoirs of the British Astronomical Association, of which he was one of the most devoted members of the observing sections. He made a fine series of observations and drawings of Mars, extracts from which were published in the Monthly Notices, the full report being placed for reference in the library of the Royal Astronomical Society, of which society he had been a fellow since 1898. He was a member of the British Astronomical Association from its foundation.

A MEDICAL congress, due to the initiative of Sir George Clarke, the Governor, is to be held in Bombay, and will begin on February 22. On the opening day Sir George Clarke will deliver the presidential address, and the sectional meetings will last during the next four days. There will be an exhibition of medical, surgical, and sanitary appliances. Among others concerned in research work specially affecting India who have expressed their intention of being present at the congress meetings are Profs. Ronald Ross, Kitasato, and Musgrave. Papers are expected to be communicated by Sir Patrick Manson, Sir Lauder Brunton, Prof. Osler, and others. The attendance at the congress is expected to be very large. The secretary of the congress is Colonel Jennings, c/o Messrs. King, King and Co., Bombay.

WE regret to see the announcement of the death of Dr. D. A. Robertson, the distinguished surgeon-oculist, at seventy-two years of age. Dr. Robertson was for several years lecturer on ophthalmology in the University of Edinburgh, and he was president of the International Ophthalmological Congress in 1894. He was an ex-president of the Ophthalmological Society of the United Kingdom, and was president of the Royal College of Surgeons, Edinburgh, in 1886, president of the ophthalmological section of the British Medical Association in 1898, and president of the Edinburgh branch of this association.

MANY geologists and other friends and fellow-workers of the late Mr. Joseph Lomas will welcome the opportunity of subscribing to a memorial fund which is being raised for the benefit of his wife and children. As was mentioned in NATURE of December 24, 1908 (p. 226), Mr. Lomas was killed in a railway accident in Algeria while on his way to study the rocks in the desert region of North Africa, this investigation being undertaken for a committee of the British Association. The devotion to scientific work which characterised Mr. Lomas meant the sacrifice of time and means that might otherwise have been used more selfishly. It is not surprising, therefore, to know that he was unable to make adequate provision for his wife and children. There should be a generous response to the appeal which has just been issued by a committee which includes the names of many distinguished men of science who knew Mr. Lomas, and of which Prof. W. A. Herdman, F.R.S., is one of the hon. treasurers. Subscriptions should be sent to the hon. treasurers, "Lomas Memorial Fund," Education Committee, 14 Sir Thomas Street, Liverpool.

ON Tuesday next, January 19, Prof. Karl Pearson will begin a course of two lectures at the Royal Institution on "Albinism in Man"; on Thursday, January 21, Prof. J. O. Arnold will commence a course of two lectures on "Mysteries of Metals," and on Saturday, January 23, Sir Hubert von Herkomer delivers the first of two lectures on (1) "The Critical Faculty," (2) "Sight and Seeing." The Friday evening discourse on January 22 will be delivered by Dr. Alfred Russel Wallace, on "The World of Life: as Visualised and Interpreted by Darwinism," and on January 29 by Sir Frederick L. Nathan, on "Improvements in Production and Application of Guncotton and Nitro-glycerin."

SINCE the great earthquake in Sicily and Calabria on December 28, 1908, there have been a number of after-shocks, and a little additional information about the disturbance. Prof. Oddone informed a Press representative on January 6 that the observatory building at Messina has been damaged, but a subterranean chamber used for seismic investigations has escaped harm. The Vicentini seismograph registered the great earthquake up to the moment of maximum intensity, and the record is considered to be of considerable interest in the study of the earthquake. From the record it appears that the earthquake began with a very slight shock, which was repeated. It increased in violence for ten seconds, and then grew less severe for another ten seconds. After these movements ten minutes passed without disturbance. A second shock of much greater intensity, and accompanied by loud subterranean rumbling, followed, and was the cause of the catastrophe. In the afternoon of January 7 several distinct shocks were felt at Reggio. Shocks continued during the whole of the night, some of them being strong ones preceded by a humming noise. On January 8 the entire west coast of Mexico was shaken by an earthquake. Three strong earthquake shocks were felt at Messina between 12.15 p.m. and 12.30 p.m. on January 9. Reuter telegrams to New York from Seattle, Bellingham, Tacoma, Vancouver, and Victoria state that an earthquake shock was felt in those places at 3.44 p.m. on January 11, and again during the evening.

WE learn from the Journal of the Royal Society of Arts that Sir Thomas Wardle, who died at his residence, Leek, Staffordshire, on January 3, in his seventy-eighth year, was the first business man to discover a satisfactory process of dyeing the wild *tussur* silk of India, and, at the instance of Sir George Birdwood, he was sent out by the Secretary of State for India, in 1885, to report on sericiculture in Bengal. This was the first of several visits to the East, and in his work, "Kashmir and its New Silk Industry" (1904), Sir Thomas Wardle gave an account of the manner in which, mainly through his instrumentality, the moribund industry was, after innumerable difficulties, placed upon a footing of greater prosperity than it had ever enjoyed before. He wrote numerous monographs upon the technical aspects of sericiculture and silk-weaving, and he was the honorary expert on silk of the Imperial Institute, president of the Silk Association of Great Britain and Ireland, and honorary secretary of the Ladies' National Silk Association. He was a Fellow of the Chemical, Geological, and Royal Statistical Societies, and a member of the council of the Palæontographical Society. He became a member of the Society of Arts in 1878. In the following year he read his first paper, on the wild silks of India, principally tussur, for which he received the society's silver medal. Since then he contributed three papers, on researches on silk fibre, the history and description of the growing uses of tussur silk, and improvements in the design, colouring, and manufacture of British silks.

THE arrangements made by the British Meteorological Office for the transmission of meteorological reports by wireless telegraphy from ships at sea were referred to in last week's NATURE (p. 287). The annual summary of the work of the U.S. Weather Bureau, recently published in the *Monthly Weather Review*, describes what is done in this direction in connection with that Bureau. The essential feature of this weather service is the collection by wireless telegraphy of meteorological observations from vessels at sea, and the dispatch by the same means to vessels at sea of weather forecasts and storm warnings based upon the observations thus collected. Vessels of the following lines, all equipped with Marconi apparatus, have been authorised to transmit to the Bureau the record of the daily Greenwich mean noon meteorological observations, and have been supplied with the telegraphic code, forms, &c., required for that purpose:—American Line, North German Lloyd, Hamburg American Line, Cunard Line, White Star Line, Compagnie Generale Transatlantique, Allan Line, and Canadian Pacific Steamship Line. The privilege has also been extended to vessels of the Panama Railroad and Steamship Company and the Mallory Line, equipped with the De Forrest system; also to the Pacific Steamship Company, equipped with the Massie system. There appears to be only one vessel on the Pacific carrying wireless apparatus. Other vessels are said to be in course of equipment, and the wireless weather service on that coast, in view of its supreme importance in the matter of local forecasting, is to be prosecuted with vigour. The wireless telegraphic weather service and code have also been adopted by the U.S. Navy Department, and all vessels of the U.S. Navy are instructed to transmit the daily weather despatch while at sea. The wireless telegraphic stations controlled by the Navy Department are also required to receive weather messages from merchant vessels and to transmit them to the Bureau, likewise to dispatch the weather forecasts and storm warnings issued by the Bureau to vessels at sea demanding them, free of cost. The total number of wireless weather reports received during 1907 from vessels at sea was 738. Of this number, 679 were from Transatlantic liners distributed along the route between Sandy Hook and longitude 44° west.

RECENTLY, Indiana University came into possession of a farm of about 180 acres, celebrated for its natural beauty and for the possession of a subterranean stream, which comes to the surface in two places before finally emerging from the base of a cliff in one of the most picturesque cave-entrances in America. Of the fauna of this tract a comprehensive account is given by Mr. W. L. Hahn in No. 1655 of the Proceedings of the U.S. National Museum, the most interesting element in this being formed by the denizens of the caves and underground stream.

IN its report for the year ending on September 30 last, the committee of the Bristol Museum and Art Gallery refer to the visit to that institution paid by their Majesties the King and Queen on the occasion of their coming to the city to open the Royal Edward Dock at Avonmouth. Lady Smyth, widow of Sir Greville Smyth, of Ashton Court, contributed during the year a munificent donation for the purpose of fitting up a room for the display of the collection of invertebrates made by her late husband and presented by herself, this chamber to be called the "Greville Smyth Room."

THE heronries of Lincolnshire and Somersetshire form the subject of an article by the Rev. F. L. Blathwayt in the *Zoologist* for December, 1908. Formerly the south-eastern portion of Lincolnshire was renowned for the number of its heronries, which included those of Leake (near Boston), Spalding, Donington, and Cressy Hall, all of which are now extinct. The Leake heronry occupied a very large tree, which was literally covered with nests, until it was felled about the year 1830; while the Cressy heronry, which was described by Pennant in 1769, contained some eighty nests. At the present day only five heronries in the county are known to the writer, the largest of which is reported to contain twenty pairs of birds.

THE *Journal of Comparative Neurology and Psychology* for November, 1908 (vol. xviii., No. 5), contains an English translation of a masterly address delivered before the third congress for experimental psychology by Dr. Ludwig Edinger, on the relations of comparative anatomy to comparative psychology. Great results, it is urged, would ensue if these two sciences were practically studied together, as is demonstrated by what has been already accomplished whenever such a union has taken place. The author lays great stress, from a psychological point of view, on dividing the brain into a "palæencephalon" and a "nëencephalon," the latter comprising the hemispheres, and the former all the remainder of the structure. The palæencephalon is alone present in bony fishes, and since in all vertebrates a totally different (nëencephalic) type of activities makes its appearance, the importance of a close psychological study of fishes is self-evident. Not only all the activities commonly termed reflex, but all instincts are localised in the palæencephalon, as is demonstrated by the fact that flight when surprised, migrations, nest-building, courtship, and many other activities are noticeable in the bony fishes. With the appearance of the nëencephalon the behaviour of the animal undergoes a complete change. Something has been done in assigning their proper functions to the various divisions of the brain, but a vast amount of work still remains to be accomplished in this field; such investigations must, however, be carried on both anatomically and psychologically at the same time, when observations on the living animal are impossible, if any good result is to accrue.

IN the December (1908) number of the *Bio-Chemical Journal* (iii., No. 10) Prof. Moore discusses the question of variation of the amount of free hydrochloric acid of the gastric contents in cancer, particularly in relation to some recent criticisms of his results, and maintains that, generally, the free hydrochloric acid of the gastric contents is diminished in cancer cases, no matter in what part of the body the disease is situated.

IN the Bulletin of the Johns Hopkins Hospital for December, 1908 (xix., No. 213), Mr. Victor Bloede discusses a comprehensive scheme for dealing with tuberculosis. It contemplates the combined and simultaneous operation of four agencies, each indispensable in itself:—(1) the dispensary where the cases are investigated, diagnosed, and classified; (2) the hospital for advanced cases; (3) the sanatorium for incipient cases; (4) the farm colony for the after-treatment of arrested cases, where the patients receive further benefit to their health and are gradually restored to the rank of self-respecting workers, as well as contributing something to the upkeep of the institutions.

WE have been favoured with a copy of the exchange list of seeds of hardy herbaceous plants and of trees and shrubs issued by the director of Kew Gardens as Appendix I. to the *Kew Bulletin* of the current year.

IT is noted in the report for 1907–8 on the botanic station, Montserrat, that the cultivation of cotton on the island is making very favourable progress, as the outturn was double that of the previous year. Of various experiments carried out by the curator, Mr. Robson, the one most generally interesting was intended to ascertain whether the clean and fuzzy cotton seeds produced plants true to type; such was found generally to be the case, and fortunately so to a larger extent in the case of the fuzzy seed that is associated with the better quality of lint.

THERE is a conflict of opinion regarding the value of the special bacterial cultures that have been introduced with the view of increasing the nodule formation, and therefore the productiveness, of leguminous plants. Experiments with nitro-bactrine, carried out at the Royal Horticultural Society's Gardens, and described in the Journal (vol. xxxiv., part ii.) by Mr. F. J. Chittenden, are decidedly adverse. Trials were made with inoculated soil and inoculated seed both on untreated and manured soil; but despite the fact that the soil is naturally lean, and therefore, it would be supposed, specially suitable for inoculation, the nitro-bactrine effected no improvement in the crops. It should be noted that all the experiments were confined to the cultivation of peas.

Two papers occupy a large portion of the nineteenth report of the Missouri Botanical Garden. Mr. C. S. Sargent contributes a memoir on the species of the critical American genus Cratægus found in Missouri. He identifies no fewer than 110 species, of which a large number are endemic, and more than half are new to science; this, by the way, is said to be a preliminary study. The second paper, dealing with the types of vegetation found in a normal cross-section taken across the Mississippi River near St. Louis, is communicated by Mr. H. Hus. The physiographical divisions on either side of the river are distinguished as bottom-lands, bluffs, and highlands. Forests and limited prairies are characteristic of the highlands. In the forests the black oak, *Quercus coccinea*, associated with other oaks and hickories, is dominant. Curious features are the sink-holes, originally forming entrances to caves, that have in many cases been closed, when the holes have been transformed into ponds. *Hydrastis canadensis*, *Polygonatum giganteum*, and *Arisaemum triphyllum* are characteristic plants found therein.

BULLETIN No. 118 of the Perdue University Agricultural Experiment Station, drawn up by Messrs. Troop and Woodbury, contains popular instructions for fruit-growers on various common orchard pests. Methods of recognition are given and remedial measures are described; there is also a good deal of sound advice on general management. Bulletin No. 116 of the West Virginia University Agricultural Experiment Station deals with the same subjects as they affect the West Virginian fruit-grower. In view of the increasing attention that is being devoted in this country to the improving of orchards, and in particular to spraying, English horticultural instructors will find much to interest them in these publications.

THE Imperial Agricultural Department of the West Indies has issued a bulletin, by Mr. Stockdale, dealing with the fungus diseases of cacao and the sanitation of cacao orchards. The diseases described are canker, "die-back" (caused by *Diplodia cacaoicola*), lasiodiplodia, "pink disease" (caused by *Corticium lilaco-fuscum*), thread blights (*Marasmius equicrinus* and other fungi), witchbroom disease (*Exoascus theobromae*), and others. Most of these diseases have been under experiment for some years, having been investigated by Mr. Howard in 1901, and it has been satisfactorily demonstrated that they are amenable to treatment. The methods found to be most effective are collected together, and the bulletin thus affords an interesting survey of the work done up to the present on this particular subject.

THE current issue of the *Transvaal Agricultural Journal* is up to its usual high standard, and includes a number of articles of local importance, besides others of more general interest. Dr. Theiler gives an account of the results he has obtained by inoculating sheep against blue tongue. He finds that vaccination is more effective, and attended with less risk, than the older method of simultaneous serum and virus injection. The mortality returns from vaccinated portions of the flocks compare instructively with those from unvaccinated portions; 11 per cent. of the unvaccinated sheep died, but only 0·4 per cent. of those vaccinated. It is a matter of fundamental importance to the Transvaal farmer, and of great credit to the Transvaal Agricultural Department, that this disease should have been brought under control. The number of diseases, both of animals and of plants, in the Transvaal is great, but is steadily being rendered less formidable by the persistent efforts of the Agricultural Department.

THE work of the agricultural experiment station in connection with the University of Maine is at the present time organised under four departments—chemistry, entomology, vegetable pathology, and biology. The work is entirely investigational, except in the department of chemistry. With a single exception, none of the staff does any teaching or has any duties other than those directly connected with the work of his department. We have received a report on the work of the biological department. The general problem on which the department is working is that of genetics, which is studied by observational, experimental, and statistical methods of biological investigation. The work is carried on in two laboratories. In addition, the department has available what is probably one of the largest and best equipped experimental poultry plants anywhere in existence. The work in plant breeding proper and on any problems which involve the use of plants as material is at the present time being carried on on rented land. The work of the department falls at present into three general lines of investigation as follows:—genetics, physiology of reproduction in the domestic fowl, and the laws of growth. Each of these topics may be considered somewhat in detail. The work in *genetics* includes hybridisation studies, the influence of selection upon the inherited characters of organisms, and quantitative studies of the method and degree of inheritance of various characters in plants and in poultry. Under the physiology of reproduction are being studied the physiology of egg production within the individual, the physiology of egg production within the race, the influence of environmental factors (in the broadest sense), the relation of internal factors to, and their influence upon, processes, and the pathological and teratological cases relating to egg production. During the present year a detailed study of the growth of the maize plant has been made, with particular reference to the following factors:—gametic constitution of the growing individual, intra-individual variation, and racial variation.

IN the *National Geographic Magazine* for December last Mr. A. J. Mayer describes a cruise along that most neglected part of the Atlantic coast lying between the mouth of Chesapeake Bay and north Florida. In the course of the voyage we pass from a temperate region of chestnuts and beeches to the border lands of the tropics in the Florida palmetto groves. In the animal world there is ample evidence of the wanton destruction of life—waterfowl, wild turkey, deer, bears, and alligators—while the forests are disappearing under the axe or are being destroyed by the wasteful turpentine industry. Unless early measures are taken to conserve the game and forests, a region which might become the favoured haunt of the sportsman and naturalist will be converted into a barren waste.

THE January issue of the *Reliquary* contains two useful articles on early ceramics. The first, by Mr. A. G. Wright, curator of the Colchester Museum, describes the collection of late Celtic and Roman pottery in his charge, which, for the number of specimens and the great variety of wares, is probably unequalled in northern Europe. Specially remarkable is the splendid cinerary urn of the Bronze age, the second largest of its class discovered in Britain, the other and greater example being preserved in the Devises Museum. Among the vessels of the Iron age, the pedastelled vases, derived, as Dr. A. J. Evans has pointed out, from the Situla in vogue south of the Alps about the fourth or fifth centuries B.C., deserve notice. Two groups of fine Celtic sepulchral vessels found at Colchester and Braintree are figured and described. The second paper, by Mr. M. E. Cunnington, discusses a find of fragments of Arretine ware from a late Celtic rubbish-heap at Oare, in Wilts. This ware is particularly rare in England, because just about the time when this country came under Roman domination it was superseded by the red-glazed Gaulish ware from the potteries established at Graufesenque in the middle of the first century A.D.

PROF. T. LEVI CIVITA has published in the *Atti dei Lincei*, xvii. (2), 1, a discussion of the attraction exerted by a material line on points in its immediate neighbourhood. The object is to discuss, by rigorous methods of modern analysis, the asymptotic forms to which the potential and its derivatives tend as the point approaches and ultimately lies on the line itself. The same methods are applicable, as Prof. Levi Civita shows, to the vector potential of a vortex filament. This corresponding hydrodynamical problem was first discussed by Da Rios in 1906. Readers of ordinary text-books will know that the expression for the translational velocity of a circular vortex commonly given contains a logarithm which becomes infinite at a point on the vortex itself. In a further paper in the same journal (xvii. [2], 9) the attraction of a thin tube of finite density is discussed.

ON December 7, 1908, Mr. Herbert Chatley gave a lecture on mechanical flight before the Society of Engineers. The printed account of the lecture contains about as clear and concise a statement of the present position of the problem as could possibly be condensed into fifteen pages. The relative advantages of the aëroplane, helicoptère and ornithoptère are briefly stated, but the point most emphasised is the need for scientific research both in connection with the study of air resistance and in connection with stability. These researches are bound to come sooner or later, for the work is perfectly well defined and straightforward, and want of opportunity has been the only hindrance which has given the lead to methods of trial and error. Mr. Chatley does not anticipate that aërial navigation will cause any great revolution in war and commerce for some years to come. He, however, wishes to point out the deplorable backwardness of English invention in this direction.

PROF. M. LAUE, in the *Physikalische Zeitschrift*, ix., 22, pp. 778–80, directs attention to an apparent paradox in the application of the concept entropy to radiation phenomena. If a beam of light falling on the surface separating two media is broken up into a reflected and a refracted beam, the two are capable of being re-united, under ideal conditions, into a single beam, and no entropy change can accompany the process. On the contrary, two beams from different sources, but identically similar in all other respects (non-coherent beams), cannot be so united, and their total entropy is apparently greater than that of the original beam. According to the statistical or probability definition of entropy, the difference is easily accounted for. On the thermodynamic aspect, the entropy of the coherent beams as a whole appears different from the sum of the entropies of the parts if the latter are estimated for each part independently without taking account of the presence of the other. The properties do not appear to be out of accord with the laws of thermodynamics so far as these are defined in terms of changes of available energy due to irreversible transformations. The available energy of a beam of light is increased by the presence of a coherent beam, and if a pair of such beams could be generated from independent sources we should undoubtedly be able to overcome the second law (and make our fortunes?), but such a possibility is contrary to existing experience.

THE method of thermal analysis, *i.e.* the observation of the change of temperature with time of a material in a cooling furnace, has been used so extensively in metallurgical research during the last twenty years, and has assumed so many different forms in the hands of experimenters, that the critical examination of the various methods from both experimental and theoretical points of view which Mr. G. K. Burgess contributes to the November (1908) number of the Bulletin of the Bureau of Standards will be welcomed by all metallurgists. Mr. Burgess comes to the conclusion that from both points of view the most certain and complete data may be obtained by combining the observations of variation of temperature with time with those obtained by taking the differences of temperatures of the material under test and a standard material cooling under the same conditions. He points out, however, that for accurate quantitative work it will be further necessary to take into account the effect of the cooling of the furnace itself on the rate of cooling of the specimen within it.

IN NATURE of November 19, 1908 (vol. lxxix., p. 75), Prof. Perry directed attention to the admirable pioneer work in the practical teaching of science and technology done by the late Prof. Ayrton so long ago as 1879 at the Finsbury Technical College. Sir Oliver Lodge, in a letter to NATURE (vol. lxxix., p. 129), supplemented this information by an account of similar work accomplished, certainly in 1872 and perhaps as far back as 1866, at King's and University Colleges in London by Prof. Carey Foster and others. Prof. Chas. R. Cross, of the Massachusetts Institute of Technology, Boston, U.S.A., now sends us a printed copy of a report on the physical laboratory of the institute written by Prof. E. C. Pickering, then Thayer professor of physics at the institute, which shows that in 1864 President Rogers proposed a laboratory for the institute in which "the student may be exercised in a variety of mechanical and physical processes and experiments"; and in October, 1868, "a room was opened to advanced students where they carried on physical investigations, as is done by many physicists with their special students." It appears evident that even more than forty years ago several men of science were beginning to appreciate the need, which is now recognised universally, for properly organised experimental work by students themselves if the instruction given in physical science is to be thorough and satisfactory.

THE Berlin Photographic Company, 133 New Bond Street, W., has sent us several portraits of distinguished men of science from a collection published by the company under the title "Corpus Imaginum." The portraits are photogravures on plate paper, the size of the picture itself being in each case about 6 inches by 9 inches, and the price of each plate is 3*s*. We have no hesitation in saying that the portraits are extremely fine, and that they should decorate the walls of many studies and schools. The portrait of Lord Kelvin, which is among the selection sent to us, is certainly the truest picture of him we have ever seen. Among other eminent men of science included in the collection published by the company are Bunsen, Cuvier, Darwin, Faraday, Helmholtz, Herschel, Huxley, Liebig, Lister, Mendeléeff, Newton, Owen, Pasteur, Sir

W. Ramsay, Richthofen, and Tyndall. We miss, however, a number of well-known names, as, for instance, the following, who have occupied the president's chair of the Royal Society:—Sir Joseph Banks, Sir Humphry Davy, Sir Joseph Hooker, Sir George Stokes, Sir William Huggins, Lord Rayleigh, and also the present president, Sir Archibald Geikie. Perhaps the company will be able to extend its collection of portraits by the addition of these and a few other British men of science of world-wide renown.

THE Selborne Society has revived the old title of its magazine, which will henceforth be called *The Selborne Magazine (and Nature Notes)*, and will be published by Messrs. George Philip and Son, Ltd., 32 Fleet Street, E.C. All communications with regard to the society should be addressed to the honorary general secretary, Selborne Society, 20 Hanover Square, London, as heretofore.

THE January number of *Knowledge and Scientific News*, which is the first number of the enlarged series, contains a five-page illustrated article on the Cavendish Laboratory and Sir J. J. Thomson from the pen of Dr. A. Wood, who has himself worked in the laboratory for the last half-dozen years. He gives an outline of the history of the laboratory, and points out the prominent position it has taken in the march of science during the last twenty years. Views of the original laboratory and of the extension recently opened by Lord Rayleigh are given, but readers will value most the excellent reproduction of the portrait of Sir J. J. Thomson, in which he has his hand on the commutator of an induction coil and his keen eye on the vacuum tubes in front of him.

OUR ASTRONOMICAL COLUMN.

FURTHER PHOTOGRAPHS OF MOREHOUSE'S COMET.—Prof. Barnard describes, and reproduces, more photographs of comet 1908*c* in the December (1908) number of the *Astrophysical Journal* (vol. xxviii., No. 5, p. 384). The four reproduced were selected because they illustrate so well the remarkable changes which took place in the comet; they were taken on October 14, 15, 16, and 30, 1908.

These changes have been described before, but Prof. Barnard directs attention to one or two peculiarities of especial interest. A comparison of the plates taken on October 15 and 16 appears to indicate that there was no acceleration of the motion of the ejected matter in the direction of the length of the tail. From the photographs taken on the former date it appears to Prof. Barnard that the ejected masses moved southwards at a greater rate than did the comet, thus producing the observed changes in position angle of the various sections of the tail.

Prof. Barnard believes that the masses forming the tail were actually ejected by the action of the comet itself to a large extent, and states that both in this and in Daniel's comet he observed pulsations of light at irregular intervals, such as might be expected to accompany the violent actions which would eject such masses. He also directs attention to the great difference between the visual and the photographic brightness of this comet; in a moonlit sky the tail could not be observed visually, yet a good photograph, showing an extension of eight or nine degrees, was obtained when the moon was 10½ days old.

According to the measures of the photographs taken on October 15 and 16 respectively, the uniform value of the recession of the detached masses was about 3'·5 per hour.

SEARCH-EPHEMERIS FOR HALLEY'S COMET.—A search-ephemeris for Halley's comet, submitted by an unnamed competitor for the Astronomische Gesellschaft prize, appears in No. 4295 of the *Astronomische Nachrichten* (p. 369, December 31, 1908). It gives the computed positions of the comet at intervals of ten days for the present year, and for every fourth day, commencing at January 2, in 1910. Observers should remark that this ephemeris differs, for the present epoch, from that previously given by Messrs. Cowell and Crommelin, whilst the difference between it and that computed by Dr. Smart (Monthly Notices, March, 1908, p. 394), for January 2, 1910, amounts to more than 3h. in R.A. and to nearly 4° in declination.

THE DISTRIBUTION OF ERUPTIVE PROMINENCES ON THE SOLAR DISC.—Some interesting statements concerning the nature and distribution of eruptive prominences on the sun's disc, and of their relations to spots, are made by Mr. Phillip Fox in No. 4, vol. xxviii., of the *Astrophysical Journal*.

From observations made with the Rumford spectroheliograph, Mr. Fox deduces that the especially brilliant points in the flocculi adjacent to spots, designated "eruptions" by Hale and Ellerman, are the bases of eruptive prominences. Evidence of this has accrued from the fact that when these eruptions have been observed near the limb, they have been found to coincide with eruptive prominences projecting above the limb.

The position of these eruptive prominences in relation to spots leads to the conclusion that the spot is preceded by, and has its genesis in, an eruption; this appears to be so generally the rule that Mr. Fox thinks it is safe to predict the advent of a spot whenever an isolated eruption is observed.

An examination of all the $H\alpha$ spectroheliograms shows that solar vortices are counter-clockwise in the northern and clockwise in the southern hemisphere.

Mr. Fox suggests that the location of eruptive prominences between the members of well-developed spot groups, and their absence in front of the leading spot, may be due, at least in part, to the interference of the whirls circulating around the various spots.

DOUBLE-STAR ORBITS.—The orbits of η Cassiopeiæ and γ Coronæ Borealis are re-discussed, in the light of the more recent observations, by Prof. Doberck in No. 4296 of the *Astronomische Nachrichten* (pp. 383–6, January 2), and revised elements are given for each.

According to these elements, the period of the former star is 507·60 years and the eccentricity of the orbit is 0·5220, whilst for γ Coronæ the corresponding figures are 81·49 years and 0·3908.

ERRORS IN MEASURES OF STAR IMAGES AND SPECTRA.—Some results of great importance to those concerned in the photographic determinations of stellar positions, and of the wave-lengths of stellar spectra, are published by Prof. Perrine in Bulletin No. 143 of the Lick Observatory.

The experience of everyone engaged in such work is that the discordances found in the measures are greater than can be accounted for by errors of measurement alone, and, whilst developing the method of determining stellar parallaxes by photography, Prof. Perrine has investigated the source of the outstanding discordances. His results indicate that the irregularity, in size and distribution, of the grains in the photographic film is the chief source of the trouble. Instead of each star image being a regular collection of equally sized grains, it is a complicated and irregular gathering of particles intersected by lanes and vacant spaces, and composed of bodies of different sizes. This irregularity leads to errors of setting, because the centre of such an agglomeration is so indefinite, and may depend more upon the structure of the particular part of the film acted upon than upon true position of the area illuminated.

PHYSICAL OBSERVATIONS OF THE NATIONAL ANTARCTIC EXPEDITION.[1]

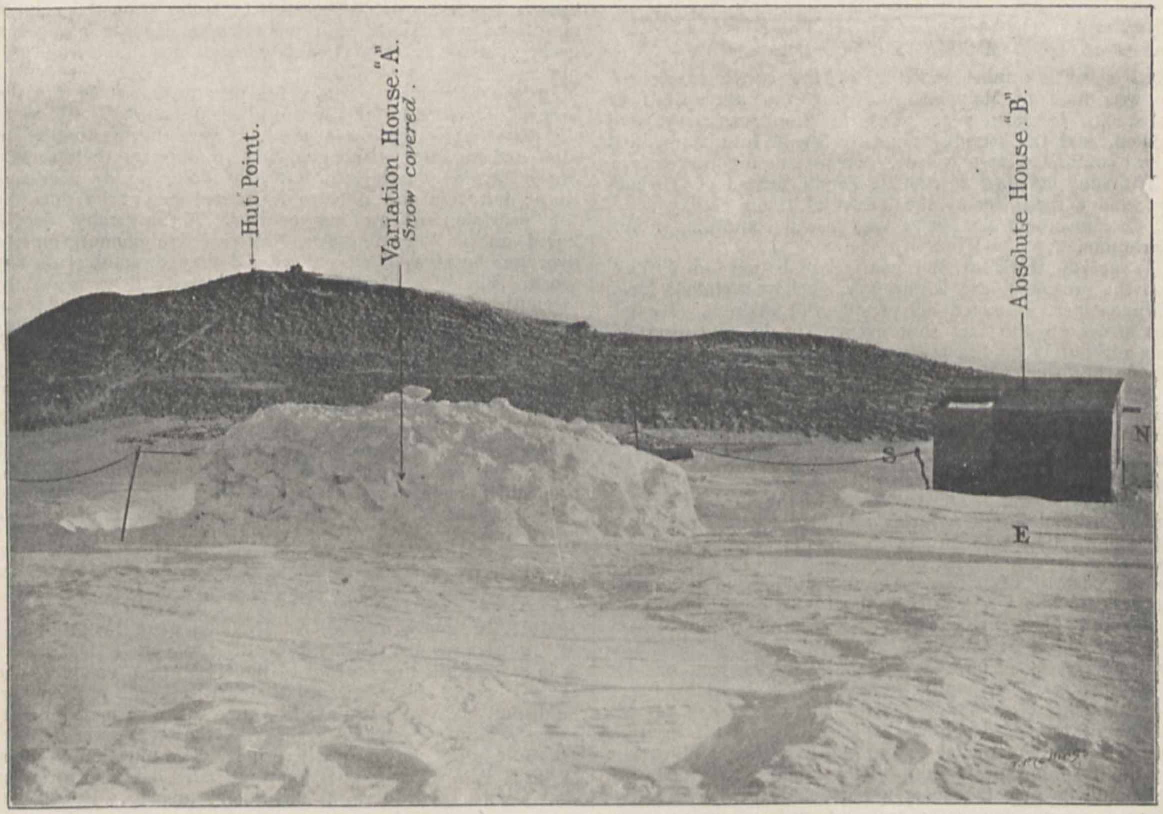
THE series of volumes now being issued by the Royal Society detailing the scientific observations made in the course of the *Discovery* expedition should impress upon the public the extent and variety of the problems that are under consideration, as well as inform them of the degree of success that has attended the efforts of those who have had to make the observations in trying circumstances. Many, unfortunately, fail to grasp the real object of such

[1] "Physical Observations, with Discussions by Various Authors." Prepared under the superintendence of the Royal Society. Pp. v+192. (London: Publish d by the Royal Society, 1908.)

expeditions, since an approach towards the Pole has acquired so much significance in popular estimation. An examination of the present volume, however, is calculated to offer a wider view with truer perspective. In it are presented the results of only a portion of the physical observations, those having reference to tides, pendulum experiments, earthquakes, and auroral and magnetic phenomena. Following the plan adopted in the meteorological observations, the Royal Society has placed the preparation of the reports on these subjects in the hands of authorities most competent to deal with them.

The tidal observations, extending from May 12, 1902, to September 20, 1903, have been discussed by Sir G. H. Darwin, who remarks that though the tidal constants derived by harmonic analysis may not be sufficiently accurate to give the means of constructing a tide-table for Ross Island, they are sufficiently trustworthy to afford an insight into the nature of Antarctic tides. The sum of the semi-ranges of the three principal diurnal tides amounts to 21·6 inches, and of the three semi-diurnal tides to 3·4 inches, consequently the effect of the semi-diurnal tides is scarcely noticeable on a simple inspection of the tidal curves; but a further investigation shows that the semi-diurnal tide exhibits a progressive change both in amplitude and phase as the season advances. The cause of this change it is not easy to determine, since there is no astronomical tide that can give an annual inequality in the semi-diurnal tide of sufficient amount to account for the perturbation. The tidal observations made in the *Scotia* have been reduced by Messrs. Selby and Hunter, of the National Physical Laboratory, and have been incorporated in this volume. The tides in the South Orkneys, the *Scotia* station, are normal for a place in the Southern Ocean. The semi-diurnal tides are considerable, and the solar tide is large in comparison with the lunar tide, the ratio being 0·6, as against 0·465 required by the equilibrium theory.

The pendulum observations, made on several occasions at the winter quarters, have been discussed by Dr. Chree, who regrets that a trained physical observer did not accompany the expedition, but gratefully acknowledges the readiness with which Messrs. Bernacchi and Skelton undertook the necessary work of mounting the instruments, and the care with which they carried out the observations. These observers exhibited remarkable skill and ingenuity in overcoming difficulties connected with the apparatus, and what value the observations possess is due to the patience and devotion of these officers. The mean observed value of gravity is slightly in excess of the theoretical, and similar results have been obtained by other observers in the Australian continent. There is, too, a considerable discrepancy between the results obtained at the winter quarters in February and in September, the explanation of which it is not easy to see, as the temperature and pressure were nearly the same. Mr. Bernacchi is inclined to attribute this difference to the large northward movement of ice in the Antarctic summer prior to February. Dr. Chree quotes this opinion without endorsing it.



National Antarctic Expedition: View of Magnetic Houses at Winter Quarters. From "Physical Observations."

The earthquake records discussed by Prof. Milne disclose the existence of a centre of seismic activity situated to the south of New Zealand, no fewer than 136 earthquakes having been recorded in the twenty-one months the apparatus was at work. The most interesting feature in the discussion has been to confirm a suspicion that Prof. Milne entertained, that earthquake shocks could reappear at antipodal stations without being recorded at intermediate positions. New Zealand being nearly at our antipodes, he had noticed that many earthquakes having their origin in or near that colony were registered at English stations, particularly at Bidston, without disturbing the instruments at observatories remote from that diameter. Prof. Milne remarks that he has met with a number of instances "where the movement from an epifocal area has travelled round and through the world to reappear as a recordable quantity at its antipodes."

The pictures of the aurora reproduced from the drawings of Dr. Wilson are very striking, but Mr. Bernacchi remarks that though the phenomenon is frequent the display is not brilliant. The light is comparable with that of the Milky Way, and the moonlight between the first and third quarters is usually sufficient to overcome that of the aurora. Owing to this feeble light, the spectroscopic observations were not successful. On some occasions the characteristic yellow line near D was seen in a direct-vision spectroscope, but no record was obtained by photography, though plates were exposed from a few minutes to twenty-four hours and longer.

In the last section Commander Chetwynd and Dr. Chree discuss the results of the magnetic observations. One interesting result is the determination of the position of the south magnetic pole by the method of observed declinations and inclinations. The results are as follows:—

By declination ...	72° 50′ S. lat. ...	156° 20′ E. long.
,, inclination ...	72° 52′ ,, ...	156° 30′ ,,

The close agreement is curious and eminently satisfactory.

THE NORTH OF ENGLAND EDUCATION CONFERENCE.

THE seventh annual meeting of the above conference was held at Manchester during the latter half of last week, January 7–9. The meeting was very well attended, and the arrangements for social intercourse and general comfort were excellent. There was a conversazione on Thursday evening at the Municipal School of Technology, and a reception at the Town Hall on Friday evening. A convenient handbook was issued containing a full programme.

The actual work of the conference began on Friday, when the president, the Right Rev. Bishop Welldon, Dean of Manchester, delivered his presidential address. He put great stress on the fact that everything in education depends ultimately on the teacher, who cannot be too highly trained; but the success of education depends also on the completeness with which the good scholar can ascend the educational ladder right up to the university. The ultimate aim of all educational efforts is "to fit the young, young men and women alike, to be good husbands and wives, good parents of families, good citizens."

In his address on "The Incidence of the Cost of Education," Lord Stanley of Alderley appealed for more Government aid in the shape of money, and he suggested that a Royal Commission should be appointed in order to inquire into the cost of education. He maintained, in any case, that a large share of the cost should be borne locally by the levying of rates, whereas Alderman Oulton (Liverpool) was rather in favour of increased taxation for educational purposes. There was general agreement on one point—that more money is necessary. It is to be hoped that this suggestion made during the conference on the question of increased financial aid will bear fruit in some form or other. We want to get the best men and women into the teaching profession. They must be well trained, and should be able to expect a reasonably adequate return for the expense of their training and education. The building of modern schools and their outfitting of course also cost money, and every teacher knows how much better he can teach in a good and well equipped than in a poorly furnished and badly lighted and ventilated classroom.

In the afternoon "The Supply of Teachers" was under discussion. It appears that the supply far exceeds the demand at present, but that circumstances should be made use of to weed out inefficient teachers and replace them by better ones. "The Teaching of Languages" and "The Training of Girls in Domestic Subjects" also came in for debate during the afternoon. In the former, Prof. Sonnenschein appeared as the champion of Latin, though not to the exclusion of German and French. French might even be taken at school before Latin. In the latter, Miss Margaret Ashton argued that it would not be right that girls and boys should be educated entirely on the same lines.

On Saturday, at the general meeting, "The Coordination of the Curricula in Primary and Secondary Schools" formed the subject of a paper by Mr. Paton (Manchester Grammar School). He maintained that the teaching of science is adequately cared for in the school curricula, but that there is a lack of continuity in the teaching of classics. He mentioned the fact that at the present day most members of the Church, of the Civil Services, of the journalistic and diplomatic professions have been through mainly a classical education; and he held that therefore more attention should be paid to classical education. Most men of science, however, would arrive at the opposite conclusion. Reference may here be made to some remarks made by Lord Fitzmaurice at a recent Royal Society dinner, and quoted by Sir E. Ray Lankester in one of his essays "From an Easy Chair." "It is every day becoming more and more certain that science is the master." Lord Fitzmaurice further said that at no distant date it may be considered not only reasonable, but necessary, to replace the present-day diplomatists by men of science.

We must always remember, however, that the teaching of science at school is still a comparatively recent development. We are not only still learning and experimenting how to teach the subject as well or better than the ancient languages are taught, but we have to contend against a great deal of traditional, and perhaps not unnatural, prejudice.

In the afternoon a powerful plea was put in for the evening instruction of the so-called "masses." There is no doubt that there are really a very large number of men and women workers willing to improve their minds, not only along technical, but also along purely academic lines; but this can only to a limited extent be done by the provision of evening courses. A university degree based on an "evening-class" knowledge cannot, on the average, be so well earned as a degree depending on day work. The idea of giving full university degrees on the strength of evening work should not be encouraged; but everything should be done by universities to encourage the attendance of day workers as students at evening classes in order to cultivate their minds, without any intention of taking a degree. Scholarships obtained at evening courses might then lead on to day courses.

A detailed discussion on the subject of "Methods of Teaching Mathematics" concluded the business of the conference on Saturday afternoon. On this occasion the two chief papers were read by Mr. Garstang (Bedales School, Petersfield) and Mr. Brotherton (School of Technology, Manchester).

THE ÆTHER OF SPACE.[1]

THIRTY years ago Clerk Maxwell gave in this place a remarkable address on "Action at a Distance." It is reported in the Journal of the institution, vol. vii., and to it I would direct attention. Most natural philosophers hold, and have held, that action at a distance across empty space is impossible; in other words, that matter cannot act where it is not, but only where it is. The question, "Where is it?" is a further question that may demand attention and require more than a superficial answer. For it can be argued on the hydrodynamic or vortex theory of matter, as well as on the electrical theory, that every atom of matter has a universal, though nearly infinitesimal, prevalence, and extends everywhere, since there is no definite sharp boundary or limiting periphery to the region disturbed by its existence. The lines of force of an isolated electric charge extend throughout illimitable space; and though a charge of opposite sign will curve and concentrate them, yet it is possible to deal with both charges, by the method of superposition, as if they each existed separately without the other. In that case, therefore, however far they reach, such nuclei clearly exert no "action at a distance" in the technical sense.

Some philosophers have reason to suppose that mind can act directly on mind without intervening mechanism, and sometimes that has been spoken of as genuine action at a distance; but, in the first place, no proper conception or physical model can be made of such a process, nor is it clear that space and distance have any particular meaning in the region of psychology. The links between mind and mind may be something quite other than

[1] Abstract of discourse delivered at the Royal Institution on February 21, 1908, by Sir Oliver Lodge, F.R.S.

physical proximity, and in denying action at a distance across empty space I am not denying telepathy or other activities of a non-physical kind; for although brain disturbance is certainly physical and is an essential concomitant of mental action, whether of the sending or receiving variety, yet we know from the case of heat that a material movement can be excited in one place at the expense of corresponding movement in another, without any similar kind of transmission or material connection between the two places; the thing that travels across vacuum is not heat.

In all cases where physical motion is involved, however, I would have a medium sought for; it may not be matter, but it must be something; there must be a connecting link of some kind, or the transference cannot occur. There can be no attraction across really empty space; and even when a material link exists, so that the connection is obvious, the explanation is not complete, for when the mechanism of attraction is understood it will be found that a body really only moves because it is pushed by something from behind. The essential force in nature is the *vis a tergo*. So when we have found the "traces," or discovered the connecting thread, we still run up against the word "cohesion," and ought to be exercised in our minds as to its ultimate meaning. Why the whole of a rod should follow, when one end is pulled, is a matter requiring explanation; and the only explanation that can be given involves, in some form or other, a continuous medium connecting the discrete and separated particles or atoms of matter.

When a steel spring is bent or distorted, what is it that is really strained? Not the atoms—the atoms are only displaced; it is the connecting links that are strained—the connecting medium—the æther. Distortion of a spring is really distortion of the æther. All stress exists in the æther. Matter can only be moved. Contact does not exist between the atoms of matter as we know them; it is doubtful if a piece of matter ever touches another piece, any more than a comet touches the sun when it appears to rebound from it; but the atoms are connected, as the comet and the sun are connected, by a continuous *plenum* without break or discontinuity of any kind. Matter acts on matter only through the æther. But whether matter is a thing utterly distinct and separate from the æther, or whether it is a specifically modified portion of it—modified in such a way as to be susceptible of locomotion, and yet continuous with all the rest of the æther, which can be said to extend everywhere—far beyond the bounds of the modified and tangible portion—are questions demanding, and I may say in process of receiving, answers.

Every such answer involves some view of the universal and possibly infinite uniform omnipresent connecting medium, the æther of space.

It has been said, somewhat sarcastically, that the æther was made in England. The statement is only an exaggeration of the truth. I might even urge that it has been largely constructed in the Royal Institution, for I will remind you now of the chief lines of evidence on which its existence is believed in, and our knowledge of it is based. First of all, Newton recognised the need of a medium for explaining gravitation. In his "Optical Queries" he shows that if the pressure of this medium is less in the neighbourhood of dense bodies than at great distances from them, dense bodies will be driven towards each other, and that if the diminution of pressure is inversely as the distance from the dense body, the law will be that of gravitation.

All that is required, therefore, to explain gravity is a diminution of pressure, or increase of tension, caused by the formation of a matter unit—that is to say, of an electron or corpuscle; and although we do not yet know what an electron is—whether it be a strain centre, or what kind of singularity in the æther it may be—there is no difficulty in supposing that a slight, almost infinitesimal strain or attempted rarefaction should be produced in the æther whenever an electron came into being, to be relaxed again only on its resolution and destruction. Strictly speaking, it is not a real *strain*, but only a "stress," since there can be no actual *yield*, but only a pull or tension, extending in all directions towards infinity.

The tension required per unit of matter is almost ludicrously small, and yet in the aggregate, near such a body as a planet, it becomes enormous.

The force with which the moon is held in its orbit would be great enough to tear asunder a steel rod four hundred miles thick, with a tenacity of thirty tons per square inch, so that if the moon and earth were connected by steel instead of by gravity, a forest of pillars would be necessary to whirl the system once a month round their common centre of gravity. Such a force necessarily implies enormous tension or pressure in the medium. Maxwell calculates that the gravitational stress near the earth, which we must suppose to exist in the invisible medium, is 3000 times greater than what the strongest steel could stand, and near the sun it should be 2500 times as great as that.

The question has arisen in my mind whether, if the whole sensible universe—estimated by Lord Kelvin as equivalent to about a thousand million suns—were all concentrated in one body of specifiable density,[1] the stress would not be so great as to produce a tendency towards ethereal disruption, which would result in a disintegrating explosion and a scattering of the particles once more as an enormous nebula and other fragments into the depths of space; for the tension would be a maximum in the interior of such a mass, and, if it rose to the value 10^{33} dynes per square centimetre, something would have to happen. I do not suppose that this can be the reason, but one would think there must be *some* reason for the scattered condition of gravitative matter.

Too little is known, however, about the mechanism of gravitation to enable us to adduce it as the strongest argument in support of the existence of an æther. The oldest valid and conclusive requisition of an ethereal medium depends on the wave theory of light, one of the founders of which was your professor of natural philosophy at the beginning of last century, Dr. Thomas Young.

No ordinary matter is capable of transmitting the undulations or tremors that we call light. The speed at which they go, the kind of undulation, and the facility with which they go through vacuum forbid this.

So clearly and universally has it been perceived that waves must be waves of something—something distinct from ordinary matter—that Lord Salisbury, in his presidential address to the British Association at Oxford, criticised the æther as little more than a nominative case to the verb to undulate. It is truly *that*, though it is also truly more than that; but to illustrate that luminiferous aspect of it, I will quote a paragraph from that lecture of Clerk Maxwell's to which I have already alluded:—

"The vast interplanetary and interstellar regions will no longer be regarded as waste places in the universe, which the Creator has not seen fit to fill with the symbols of the manifold order of His kingdom. We shall find them to be already full of this wonderful medium; so full, that no human power can remove it from the smallest portion of space, or produce the slightest flaw in its infinite continuity. It extends unbroken from star to star; and when a molecule of hydrogen vibrates in the Dog-star, the medium receives the impulses of these vibrations, and after carrying them in its immense bosom for several years, delivers them, in due course, regular order, and full tale, into the spectroscope of Mr. Huggins, at Tulse Hill." (It is pleasant to remember that those veteran investigators Sir William and Lady Huggins are still at work.)

This will suffice to emphasise the fact that the eye is truly an ethereal sense-organ—the only one which we possess, the only mode by which the æther is enabled to appeal to us, and that the detection of tremors in this medium—the perception of the direction in which they go, and some inference as to the quality of the object which has emitted them—cover all that we mean by "sight" and "seeing."

I pass, then, to another function, the electric and magnetic phenomena displayed by the æther, and on this I will only permit myself a very short quotation from the

1 On doing the Arithmetic, however, I find the necessary concentration absurdly great, showing that such a mass is quite insufficient.

writings of Faraday, whose whole life may be said to have been directed towards a better understanding of these ethereous phenomena. Indeed, the statue in your entrance hall may be considered as the statue of the discoverer of the electric and magnetic properties of the æther of space.

Faraday conjectured that the same medium which is concerned in the propagation of light might also be the agent in electromagnetic phenomena. "For my own part," he says, "considering the relation of a vacuum to the magnetic force, and the general character of magnetic phenomena external to the magnet, I am much more inclined to the notion that in the transmission of the force there is such an action, external to the magnet, than that the effects are merely attraction and repulsion at a distance. Such an action may be a function of the æther; for it is not unlikely that, if there be an æther, it should have other uses than simply the conveyance of radiation."

This conjecture has been amply strengthened by subsequent investigations.

One more function is now being discovered; the æther is being found to constitute matter—an immensely interesting topic, on which there are many active workers at the present time. I will make a brief quotation from your present professor of natural philosophy (J. J. Thomson), where he summarises the conclusion which we all see looming before us, though it has not yet been completely attained, and would not by all be similarly expressed:—

"The *whole* mass of any body is just the mass of æther surrounding the body which is carried along by the Faraday tubes associated with the atoms of the body. In fact, all mass is mass of the æther; all momentum, momentum of the æther; and all kinetic energy, kinetic energy of the æther. This view, it should be said, requires the density of the æther to be immensely greater than that of any known substance."

Yes, far denser—so dense that matter by comparison is like gossamer, or a filmy, imperceptible mist, or a Milky Way. Not unreal or unimportant—a cobweb is not unreal, nor to certain creatures is it unimportant, but it cannot be said to be massive or dense; and matter, even platinum, is not dense when compared with the æther. Not until last year, however, did I realise what the density of the æther must really be,[1] compared with that modification of it which appeals to our senses as matter, and which for that reason engrosses our attention. If I have time I will return to that before I have finished.

Is there any other function possessed by the æther which, though not yet discovered, may lie within the bounds of possibility for future discovery? I believe there is, but it is too speculative to refer to, beyond saying that it has been urged as probable by the authors of "The Unseen Universe," and has been thus tentatively referred to by Clerk Maxwell:—

"Whether this vast homogeneous expanse of isotropic matter is fitted not only to be a medium of physical interaction between distant bodies, and to fulfil other physical functions of which, perhaps, we have as yet no conception, but also . . . to constitute the material organism of beings exercising functions of life and mind as high or higher than ours are at present—is a question far transcending the limits of physical speculation."

And there, for the present, I leave that aspect of the subject.

I shall now attempt to illustrate some relations between æther and matter.

The question is often asked, Is æther material? This is largely a question of words and convenience. Undoubtedly the æther belongs to the material or physical universe, but it is not ordinary matter. I should prefer to say it is not "matter" at all. It may be the substance or substratum or material of which matter is composed, but it would be confusing and inconvenient not to be able to discriminate between matter, on the one hand, and æther on the other. If you tie a knot on a bit of string, the knot is composed of string, but the string is not composed of knots. If you have a smoke or vortex-ring in the air, the vortex-ring is made of air, but the atmosphere is not a vortex-ring, and it would be only confusing to say that it was.

[1] See Lodge, *Phil. Mag.*, April, 1907.

The essential distinction between matter and æther is that matter *moves*, in the sense that it has the property of locomotion and can effect impact and bombardment, while æther is *strained*, and has the property of exerting stress and recoil. All potential energy exists in the æther. It may vibrate, and it may rotate, but as regards locomotion it is stationary—the most stationary body we know—absolutely stationary, so to speak; our standard of rest.

All that we ourselves can effect, in the material universe, is to alter the motion and configuration of masses of matter; we can move matter by our muscles, and that is all we can do directly; everything else is indirect.

But now comes the question, How is it possible for matter to be composed of æther? How is it possible for a solid to be made out of fluid? A solid possesses the properties of rigidity, impenetrability, elasticity, and such like; how can these be imitated by a perfect fluid such as the æther must be? The answer is, they can be imitated by a fluid in motion, a statement which we make with confidence as the result of a great part of Lord Kelvin's work.

It may be illustrated by a few experiments.

A wheel of spokes, transparent or permeable when stationary, becomes opaque when revolving, so that a ball thrown against it does not go through, but rebounds. The motion only affects permeability to matter; transparency to light is unaffected, until something near the speed of light itself is reached.

A silk cord hanging from a pulley becomes rigid and viscous when put into rapid motion, and pulses or waves which may be generated on the cord travel along it with a speed equal to its own velocity, whatever that velocity may be, so that they appear to stand still. This is a case of kinetic rigidity, and the fact that the wave-transmission velocity is equal to the rotatory speed of the material is typical and important, for in all cases of kinetic elasticity these two velocities are of the same order of magnitude.

A flexible chain, set spinning, can stand up on end while the motion continues.

A jet of water at sufficient speed can be struck with a hammer, and resists being cut with a sword.

A spinning disc of paper becomes elastic, like flexible metal, and can act like a circular saw. Sir William White tells me that in naval construction steel plates are cut by a rapidly revolving disc of soft iron.

A vortex-ring, ejected from an elliptical orifice, oscillates about the stable circular form, as an india-rubber ring would do, thus furnishing a beautiful example of kinetic elasticity, and showing us clearly a fluid displaying some of the properties of a solid.

A still further example is Lord Kelvin's model of a spring balance, made of nothing but rigid bodies in spinning motion.[1]

If the æther can be set spinning, therefore, we may have some hope of making it imitate the properties of matter, or even of constructing matter by its aid. But how are we to spin the æther? Matter alone seems to have no grip of it. I have spun steel discs, a yard in diameter, 4000 times a minute, have sent light round and round between them, and tested carefully for the slightest effect on the æther. Not the slightest effect was perceptible. We cannot spin æther mechanically.

But we can vibrate it electrically, and every source of radiation does that. An electrified body, in sufficiently rapid vibration, is the only source of æther-waves that we know, and if an electric charge is suddenly stopped it generates the pulses known as X-rays, as the result of the collision. Not speed, but sudden change of speed, is the necessary condition for generating waves in the æther by electricity.

We can also infer some kind of rotary motion in the æther, though we have no such obvious means of detecting the spin as is furnished by vision for detecting some kinds of vibration. It is supposed to exist whenever we put a charge into the neighbourhood of a magnetic pole. Round the line joining the two the æther is spinning like a top. I do not say it is spinning fast: that is a question of its density; it is, in fact, spinning with excessive slowness, but it is spinning with a definite moment of momentum.

[1] Address to Section A of British Association at Montreal, 1884.

J. J. Thomson's theory makes its moment of momentum exactly equal to *em*, the product of charge and pole, the charge being measured electrostatically and the pole magnetically.

How can this be shown experimentally? Suppose we had a spinning top enclosed in a case, so that the spin was unrecognisable by ordinary means—it could be detected by its gyrostatic behaviour to force. If allowed to "precess" it will respond by moving perpendicularly to a deflecting force. So it is with the charge and the magnetic pole. Try to move the charge suddenly, and it immediately sets off at right angles. A moving charge is a current, and the pole and the current try to revolve round one another—a true gyrostatic action due to the otherwise unrecognisable ethereal spin. The fact of such magnetic rotation was discovered by Faraday.

I know that it is usually worked out in another way, in terms of lines of force and the rest of the circuit; but I am thinking of a current as a stream of projected charges, and no one way of regarding such a matter is likely to exhaust the truth or to exclude other modes which are equally valid. Anyhow, in whatever way it is regarded, it is an example of the three rectangular vectors.

The three vectors at right angles to each other, which may be labelled current, magnetism, and motion respectively, or more generally E, H, and V, represent the quite fundamental relation between æther and matter, and constitute the link between electricity, magnetism, and mechanics. Where any two of these are present, the third is a necessary consequence. This principle is the basis of all dynamos, of electric motors, of light, of telegraphy, and of most other things. Indeed, it is a question whether it does not underlie everything that we know in the whole of the physical sciences, and whether it is not the basis of our conception of the three dimensions of space.

Lastly, we have the fundamental property of matter called *inertia*, which, if I had time, I would show could be explained electromagnetically, provided the ethereal density is granted as of the order 10^{12} grams per cubic centimetre. The elasticity of the æther would then have to be of the order 10^{33} C.G.S., and if this is due to intrinsic turbulence, the speed of the whirling or rotational elasticity must be of the same order as the velocity of light. This follows hydrodynamically, in the same sort of way as the speed at which a pulse travels on a flexible running endless cord, the tension of which is entirely due to the centrifugal force of the motion, is precisely equal to the velocity of the cord itself; and so, on our present view, the intrinsic energy of constitution of the æther is incredibly and portentously great, every cubic millimetre of space possessing what, if it were matter, would be a mass of a thousand tons, and an energy equivalent to the output of a million-horse-power-station for forty million years.

The universe we are living in is an extraordinary one, and our investigation of it has only just begun. We know that matter has a psychical significance, since it can constitute *brain*, which links together the physical and the psychical worlds. If anyone thinks that the æther, with all its massiveness and energy, has probably no psychical significance, I find myself unable to agree with him.

SCIENCE AND THE PRACTICAL PROBLEMS OF THE FUTURE.[1]

AT the recent conference on the conservation of resources which met at the White House at the invitation of the President of the United States, notes of warning were sounded concerning the coming exhaustion of coal, wood, ores, and soils. Whether or not we accept as exact the estimates furnished by experts on that impressive occasion, there is no doubt that we are approaching the end of our available resources, and that the near future will have momentous problems to face.

Certain things are clear.

First.—Unchecked wastefulness as exhibited, for example, in the extermination of the bison, in the destruction of forests, in the exhaustion of the soil, in the disappearance from our coasts and streams, that once teemed with fish, of this important source of food supply, in the pouring into the air of an incredible amount of unused fuel from hundreds of thousands of coke ovens, must cease, or our ruthless exploitation will bring disaster on generations soon to come. The prevention of these and countless other manifestations of individual and corporate greed is a problem for the economist and the law-maker, although they will scarcely succeed in its solution without calling science to their aid.

Second.—Saving and thrift offer at best only a postponement of the day of distress. The end of our supplies of coal and petroleum must ultimately be reached. Forests may be renewed and the soil restored to its maximum fertility, but the problem which is presently to confront the race is that of civilised existence without recourse to energy stored by the slow processes of nature. This problem must be definitely solved before the complete exhaustion of our inherited capital.

Third.—The problem is not without conceivable solution, since the annual accession of energy from the sun, did we know how to utilise it without awaiting the slow processes of storage employed by nature, is ample for every thinkable need of the future inhabitants of our planet. Estimates of the constant of solar radiation show that about 2·18 kilowatts of power is continually received from the sun for every square metre of the earth's surface, or more than seven and a half millions of horse-power per square mile. The present use of power in the United States is about eighty million horse-power, or one horse-power per capita. This quantity is likely to increase more rapidly than the population in the future unless curtailed by lack of fuel, but it is evident that a very small fraction of the sun's radiation would meet all demands.

Now abundant power is soon to be the factor upon which material advancement will chiefly depend. To obtain it in the face of the disappearance of coal and petroleum will be imperative. For success in this, upon which in the immediate future the welfare of the race and ultimately its very perpetuity is to depend, we must look to science. Mere ingenuity or inventiveness, however widely developed, will not suffice. The inventor and the engineer can but utilise and apply the material which the man of science provides, and with the exhaustion of our stores of scientific knowledge civilisation must halt.

It is of this fundamental relation of science to the progress of our civilisation that I wish to speak. The fact that material progress is based upon science seems to be but dimly understood. It appears to be generally supposed that it is to the inventor and to those who use his devices that we owe our present advantages over our forefathers. I would not belittle the achievements of the so-called practical man, but the public must be taught that application can never run ahead of the knowledge to be applied, and that the only road to higher achievement in practical things is by the further development of pure science.

The *main product* of science, using that word in its broadest sense, is *knowledge*; among its by-products are the technological arts, including invention, engineering in all its branches, and modern industry. Not all industries have attained the character of a technological art. Burning the woods to drive out game, and thus obtain a dinner, is a form of industry. Like it in character are some very large industries, such as agriculture of the sort that impoverishes the soil; lumbering that destroys forests, and incidentally ruins rivers and increases erosion; coke-making by processes that waste 40 per cent. of the energy of coal. The production of power from coal by means of the steam boiler and the reciprocating engine we at present regard as a highly developed technological art; yet it is a process which, at the very best, converts less than 10 per cent. of the total stored energy of the fuel into available form. If the ultimate purpose of this power is the production of light, we by our present methods suffer a second waste of 90 per cent. or more, so that the efficiency of the combined processes is but a fraction of 1 per cent. These things are excusable while ignorance lasts. They become criminal with realisation of the results, and are inconceivable in a community of fully developed civilisation. Science paves the way for the gradual sup-

[1] Abridged from the address delivered by Prof. E. L. Nichols, the retiring president of the American Association for the Advancement of Science, at the Baltimore meeting, December, 1908.

planting of these barbarous methods by more refined and rational processes, but they often persist long after they are known to be injurious to the public welfare because they happen to serve some selfish individual or corporate purpose. In such cases it is to science again that we must look for the development of an enlightened public opinion that will end them.

A country that has many investigators will have many inventors also. A scientific atmosphere dense enough to permeate the masses brings proper suggestions to many practically inclined minds. Where science is there will its by-product, technology, be also. Communities having the most thorough fundamental knowledge of pure science will show the greatest output of really practical inventions. Peoples who get their knowledge at second-hand must be content to follow. Where sound scientific conceptions are the common property of a nation, the wasteful efforts of the half-informed will be least prevalent. The search after perpetual motion, the attempt to evade the second law of thermodynamics, and the promotion of the impracticable are all simply symptoms of a people's ignorance.

Modern invention is a very near neighbour to the pure science of the laboratory, and the relation becomes daily more intimate. Nothing could apparently be more academic in its early development or further from the practical workaday world than the subject of electric waves. For years it was regarded as a fine field for the speculations of the mathematical physicist. Then at the hands of Hertz and his followers it became a fascinating topic for experimental investigation by men devoted to science for its own sake. Suddenly it was launched into the realm of hard-headed commercialism by a practical man, daring, enthusiastic, and optimistic enough, at a time when electric waves could be produced in one room of the laboratory and detected in the next room, to dream of sending such waves across the sea as bearers of human messages.

At every step of its development the things that have made wireless telegraphy possible have been borrowed from pure science.

While Marconi was still struggling to adapt the apparatus of Righi to long-distance transmission, the antenna and the coherer were already in use by Popoff in the study of oscillatory lightning. In the thermal detector of Fessenden the almost invisible platinum wires produced years before by Wollaston for the cross-hairs of telescopes appear in a new field of usefulness. The "lead-tree" familiar as a simple and beautiful lecture experiment in electrolysis forms the basis of the responder of De Forrest. Another form of electrolytic detector, introduced independently as the receiver of wireless signals by Schloemilch and by Vreeland, traces back to the Wehnelt interrupter. Marconi's latest receiver, the magnetic detector, is an ingenious modification of Rutherford's device for the study of electric waves, and this in turn was based on the classical experiment of Joseph Henry on the effects of the discharge of Leyden jars on the magnetisation of steel sewing needles.

It is needless to multiply examples. In the history of science and of invention this intimate relation appears to be almost universal. The environment of science has always been academic. Science has its home in the university. From Galileo and Newton to our own time the men who have laid the foundations upon which civilisation is built have nearly all been teachers and professors.

A few notable exceptions there are, such as Darwin, whose centenary we are about to celebrate. Each branch has its short list of unattached investigators—Franklin, Rumford, Carnot, Joule in physics, &c.—but the honour-roll of science is essentially an academic list.

It is necessary, in considering the place of America in science, to contrast the standing of its educational institutions, not pedagogically, but as centres of research, with those of other countries. The United States has less than its share of men of science, because it has not, as yet, universities that sufficiently foster and encourage research. When in any of its institutions a man distinguishes himself by productive work, he is frequently made a dean, director, or even president, and is thus retired from what might have been a great career as an investigator. Thereafter he is compelled to devote himself to administrative duties, which someone not equipped for the important task of adding to the world's stock of knowledge might just as well perform. It is as though the authorities were to say, X has written an admirable book, we must appoint him book-keeper; or Y is developing a decided genius for landscape, we will increase his salary and ask him to devote all his time to painting the woodwork of the university buildings. Nor does the mischief stop with the sacrifice of a few bright spirits. It extends to the bottom. The head of each department is a petty dean, cumbered with administrative detail. He is expected to hold everyone under him to account, not for scholarly productiveness, but for the things which chiefly hinder it.

In this exaltation of administrative ability over creative gifts, which are much rarer and more precious, our institutions share the weakness which pervades our industrial establishments, where the manager or superintendent usually gets larger pay and is regarded as more important than the most expert craftsman. In both we see the same striving for a certain sort of efficiency and economy of operation and for the attainment of a completely standardised product. This tends in both cases to the elimination of individuality and to sterility. In the university it retards instead of developing research. In industry it discourages originality. I would that there might be displayed in the administrative offices of every institution of higher education this testy remark, once made by an eminent scholar:—"*You cannot run a university as you would a saw-mill!*"

If anyone questions the responsibility of the American university for the shortcomings of American science, and is inclined to seek some more obscure cause for the conditions that I have endeavoured to portray, let him consider the history of astronomy in the United States. This science, for some reason, was from the first accorded favours not vouchsafed to any other branch of learning. Colleges that made no pretence of research, and had neither laboratories nor libraries worthy of the name, were ambitious to have observatories, and rich men were found to establish and endow them. The observatory implied, somehow, to the minds of the authorities an astronomer—not merely someone of good moral character who could teach the subject—and so it came about that there was one member of the college faculty who was expected to do scientific work, and was left comparatively free to observe and investigate. Modest as most of these early provisions for astronomy were, they bore fruit, and American astronomy gained standing and recognition while her sister sciences were struggling for existence. Later, it is true, there arose an ambition for laboratories, and there were laboratories; but, unfortunately, save in very rare instances, the laboratory has not implied an investigator. The conditions which made astronomy what it was have not been repeated. Productiveness has not been demanded nor expected; neither have the inmates of our laboratories been accorded that exemption from excessive pedagogical duties which would enable them to give their best strength to research.

A recent event in the educational world well illustrates the weakness of our academic attitude toward science. The head of one of our strongest, most modern, most progressive, and best equipped institutions has announced, as one of the details of a noble bequest to the University, the endowment of ten research professorships. President Van Hise declares:—

"The provisions for their support, including liberal salaries, assistants, materials, a limited amount of instructional work, and relations with students, are an epitome of the situation in the best German universities, which are admitted to stand first among the institutions of the world in the advancement of knowledge."

This is indeed an event to warm the heart of everyone who is interested in the promotion of science. All who are devoted to learning for its own sake or who realise the importance of science to the welfare of the nation will applaud that portion of the will in which this great gift is made, which reads:—

"The university may best be raised to the highest excellence as a seat of learning and education by abundant support in pushing the confines of knowledge."

Yet in very truth there is nothing to prevent the University of Wisconsin, or any other of a hundred like institutions, without awaiting the rare advent of some far-sighted benefactor, from having, not ten, but all her professorships made research professorships—nothing, alas, but the deep-seated and seemingly uneradicable conviction of the boards of control, that the endowments committed to their charge are for some other purpose.

A true university from the point of view of scientific productiveness is a body of scholars, that is to say, of men devoting themselves solely to the advancement of learning. Everyone in it, from top to bottom, should be an investigator. The entire income of a university should be expended in the promotion of science, *i.e.* of knowledge. Teaching is a necessary factor in the advancement of learning, and so a function of the university. University teaching should be done by investigators, not only because more investigators are to be developed, but because the promotion of science, on the scale which the future demands, means that science shall not remain narrowly academic, but shall more and more pervade the life of the people.

From the point of view of American institutions such a definition of the university is revolutionary, but it cannot be said to be impracticable or Utopian, for upon precisely such ideals the most successful university systems in the world have been built.

That this type will bear transplanting to American soil was triumphantly demonstrated in the work of Daniel C. Gilman, who gave the Johns Hopkins University at its inception the essential characteristics of the German universities as regards research. This successful experiment should have marked an epoch in the history of higher education, but a generation has passed and we have not as yet a university system devoted primarily to the advancement of learning. We still consider investigation merely as a desirable adjunct to university activities, never as the thing for which the university exists.

Germany, on the other hand, has for a century consistently developed the university as a centre of research, and through the promotion of pure science in the university has made German civilisation what it is to-day.

I would not be understood as urging German or other European methods in all details upon a country where quite different conditions exist, but one general principle is of universal application. In whatever we have to do, whether it be municipal administration, sanitation, road-making, the construction of water-ways, the development of industries, or the conservation of natural resources, the fullest and latest scientific knowledge should be utilised. Practice should not be permitted to lag indefinitely behind theory, and that they may go hand in hand public work and private enterprises should be in the hands of *those who know*. At the same time, science should be persistently advanced by every possible agency.

To my mind, the future of science in America, as elsewhere, is essentially a question of the future of the universities. It is conceivable that institutions may so long continue blind to their chief function as to be supplanted by some new agency called into existence to take up their neglected work. Already great endowments for the promotion of research, quite without any pedagogical feature, have come into existence. For all such science has need, and will have increasing need, as the situation becomes more acute and we are brought closer to the great crisis.

But it will be found that the conditions for maximum scientific productiveness are precisely those which would exist in the ideal university. All attempts at a machine-made science are doomed to failure. Science-making syndicates are likely to meet shipwreck on the very rocks on which the American educational system is already aground. No autocratic organisation is favourable to the development of the scientific spirit. No institution after the commercial models of to-day is likely to be generously fertile. You can contract for a bridge according to specifications. If a railway is to be built and operated, a highly organised staff with superintendents and foremen and an elaborate system reaching every detail may be made to yield the desired results. No one, however, can draw up specifications for a scientific discovery. No one can contract to deliver it on a specified day for a specified price. No employee can be hired to produce it in return for wages received.

To the investigator the considerations I have endeavoured to present are unimportant. Science for its own sake is his sufficient incentive; but it is all-important for the community at large to realise that no real addition to knowledge is useless or trivial; that progress depends on scientific productiveness; that science, which must be fostered if we are to continue to prosper, is a republic the watchwords of which are *liberty, equality, fraternity*.

World power in the near future is to be a question of knowledge—not of battleships—and what is now spent on armaments is to be devoted to its pursuit. Beyond lies that future in which it will no longer be a question of supremacy among nations, but of whether the race is to maintain its foothold on the earth.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

To perpetuate the memory of the late Sir George Livesey it is proposed to endow a Livesey professorship in gas engineering and fuel at the Leeds University. The committee having the matter in hand announces that contributions to the fund should be sent to the secretary of the Institution of Gas Engineers, 39 Victoria Street, Westminster. A sum of at least 10,000*l*. is required for the object in view.

THE University of Liverpool has received an offer from Mr. Alexander Elder, of Southport, formerly of Elder, Dempster, and Co., Liverpool, to contribute 12,500*l*. for the establishment of a chair of naval architecture in the University. The proposal will be considered by the University council at its next meeting. The foundation of such a professorship would of necessity mean a great expenditure in fitting and equipping lecture-rooms and laboratories, and in maintaining the work of the new department. It is hoped that other gifts will be forthcoming to make it possible for the council to accept Mr. Elder's generous offer.

THE Rev. Lord William Cecil is proceeding to China at the request of an influential committee of graduates of Oxford and Cambridge to try to found a Christian and educational university there. At present much educational work is being done by the American missions, but very little by the English. It is thought that one union university will be more efficient and more economical than many smaller establishments working without method. It is hoped to avoid the difficulties of divergent religious teaching by founding a university on the lines of Oxford and Cambridge. While each college of the university will be under the control of some mission body, the university itself, like Oxford and Cambridge, will not be attached to any one denomination. The university will concern itself chiefly with the teaching of arts, science, and engineering. The university is not intended to be a permanent foreign settlement in China. With the growing body of Chinese Christians, it is expected that the chairs may be filled soon with those who have been students in the university.

WE have received a printed copy of a lecture delivered by M. Jules Gautier, director of secondary education in France, last October, under the auspices of the British Education Section of the Franco-British Exhibition, on the progress of secondary education in France since the time of Napoleon I. It is interesting to notice in the lecture that science was introduced in the curriculum of French secondary schools so far back as 1821, while in 1829 the idea was prevalent that Latin and science formed a suitable training for young men wishing to enter the Army or the Diplomatic Service. In 1852 the system was introduced of dividing pupils, after the preliminary stages, into two groups, those who wanted a literary or classical education and those who wanted a scientific education, but this system was short-lived. It was not until 1902 that the present system was inaugurated. To-day French secondary education is divided into two cycles; the first is concerned with the years from ten to fourteen, and the second with the remaining school years. In the first cycle science is taught in varying amounts, and in the second cycle science is included in each of the four different courses open to pupils.

THE University of London has arranged several series of advanced lectures in science for the spring term. The lectures are addressed to advanced students of the University and to others interested in the subject dealt with. Admission is free, without ticket. A course of eight lectures on "Physical Chemistry, and its Bearing on Biology," will be given by Dr. J. C. Philip at the Imperial College of Science and Technology, S.W., on Mondays at 5 p.m., from January 25 to March 15. Four lectures on "The Use of Vertebrate Fossils in Stratigraphical Geology" will be given by Dr. A. Smith Woodward, F.R.S., at the Imperial College of Science and Technology on Mondays at 5 p.m., beginning on February 1. The reader in meteorology, Dr. W. N. Shaw, F.R.S., will give ten lectures on "The Climates of the British Possessions" at the London School of Economics on Fridays at 5 p.m., beginning on January 22. Three lectures on "The Anatomy and Zoological Relationships of the Anthropoid Apes," by Prof. Arthur Keith, will be given at the Royal College of Surgeons, Lincoln's Inn Fields, on Friday, January 15, Thursday, January 21, and Friday, January 29, at 5 p.m. Three Chadwick lectures on "The Medical Aspects of Recent Advances in Hygiene as connected with Sewering" will be delivered at the University by Dr. Louis C. Parkes on Tuesdays at 4 p.m., beginning on February 2.

THE Governor of Bombay recently addressed a long letter to the registrar of the Bombay University propounding a new scheme of science teaching. According to the *Pioneer Mail*, the letter concludes:—The Governor in Council is well aware of the difficulties which must attend so drastic a revision of the University curriculum as in his opinion is urgently required, and he fully recognises that the essential reforms must be gradually carried out. He is confident, however, that the Senate will approach with a single eye to the efficiency of higher education in the Presidency, the proposals which in reply to the request contained in their letter of August 8 last he now lays before them, and will share with him the earnest desire that the University of Bombay should be brought into line with the great developments in educational methods which have assumed practical form in recent years, and they will not fail to realise the bearing of these developments upon national advancement. The recent splendid benefactions towards the improvement of science teaching have removed some of the obstacles to the movement in the required direction. The most pressing questions, therefore, to which the Senate will doubtless give the earliest consideration are those relating to the proposed changes in the science courses. So soon as an agreement has been reached on the principles involved, it will be possible to take the initial steps for starting an institute in which the teaching of science can eventually be concentrated and rendered worthy of the Presidency of Bombay.

INTERESTING statistics concerning the registration of students in American universities last October are given by Prof. Rudolf Tombo, jun., in *Science* of December 25, 1908. Comparing the figures for 1908 with those of the previous year, Prof. Tombo shows that, in spite of the prevailing economic depression, only two American universities, Harvard and Stanford, show a slight loss in enrolment, whereas two years ago five universities suffered a decrease. Taking the total attendance into consideration, *i.e.* including the summer session, the greatest gains of students have been made by the universities of Chicago, Columbia, Wisconsin, Indiana, Pennsylvania, Cornell, California, and Minnesota, each one of these having gained more than four hundred students; omitting the summer session attendance, the largest increases have been registered by the universities of Columbia, Minnesota, Cornell, Northwestern, Wisconsin, Pennsylvania, and Ohio, in the order given, the growth in each case being one of more than three hundred students. The only institutions that have registered a decrease in the number of students studying science are Harvard, Kansas, Nebraska, and Virginia, and of these the first mentioned is the only one that shows a loss as compared with 1902, this being due to the fact that the baccalaureate degree is now required for admission to the Harvard engineering schools. The gain in the number of science students since 1902 is in several instances remarkable, *e.g.* from 597 to 1352 at Michigan University. The largest number of students of science is still found at Cornell University, Michigan and Illinois being the only others that attract more than one thousand students to their scientific schools; these are followed by Yale, Ohio State, Wisconsin, California, Pennsylvania, Minnesota, Columbia, Missouri, Nebraska, and Princeton, each of these universities having more than five hundred students in attendance at their scientific schools.

THE report of the British Education Section of the Franco-British Exhibition, 1908, has now been printed and circulated. Although exhibits of our educational system and its results have formed part of the several international exhibitions which have been held in various countries during the past twenty-five years, no adequate demonstration of the wide scope of the aims of British educational activity, the variety of its methods, and the magnitude of its results had ever been brought before the public within the United Kingdom before that in connection with the exhibition of last year. The exhibits were contributed by some 160 organisations in all parts of the kingdom, and were drawn from more than 1550 schools, colleges, and other educational institutions. The important place in our educational system now filled by technical instruction claimed for it special treatment. This was secured by a large collective exhibition, representative of the various types of work done by the respective technical schools and institutes of the country, the organisation of which was undertaken by the council of the Association of Technical Institutions, while the City and Guilds of London Institute showed, by an exhibit of the statistics of its department of technology, the uninterrupted progress that has been made in the organisation of practical instruction in the different branches of industrial work. Large parties of teachers from Manchester, Bolton, Nottingham, Newcastle-on-Tyne, Darlington, Wakefield, Stockton, Middlesbrough, Rochdale, Grimsby, Barry, Wimborne, and other places visited and inspected the section during August and September. Moreover, special commissioners, appointed by their respective Governments to study the methods and results of British education, came from China, Japan, Spain, Algiers, Hungary, Cuba, New South Wales, New Zealand, and other countries, while amongst the most frequent visitors in the autumn months were many teachers from the United States and Canada.

THE annual meeting of the Geographical Association was held at the London School of Economics on January 6. The morning was devoted to technical papers on methods of geographical instruction. The excellent work which the association is doing in the direction of applying scientific methods to the teaching of geography is indicative of the new spirit which is inspiring schoolmasters and schoolmistresses. Until recently it was customary to rely wholly upon the teacher's explanations, and the pupils were expected to listen and remember merely; nowadays, in the best schools, the pupil is made to take an active part in the work and to deduce geographical principles from practical exercises based on maps, the graphing of curves, the reading of measuring instruments, and many other branches of the subject. The character of the morning papers read to a large and interested audience of teachers reflected this gratifying change. The afternoon session also was largely attended. It was announced that the membership had increased by 250 during last year, and is now 793. In his presidential address Mr. Douglas Freshfield said he had brought one satisfactory item of news from the Royal Geographical Society, namely, that the council of the Royal Geographical Society and the University of Oxford have agreed to maintain their respective contributions to the Oxford School of Geography for another period of five years. The school grows in size and reputation, and it only remains for some pious benefactor, some city company, or colonial millionaire to build himself a lasting monument by providing the school with a suitable home worthy of the first school of geography in the British Empire. At Cambridge also the geographical spirit is active, and new developments may be expected. Extension meetings in the summer spread university teaching far and wide, and everywhere there are signs that teachers who take an interest in their subject are multiplying, and that the conception of geography as a study for mental discipline is spreading. No one in touch with education speaks apologetically nowadays of geography. It has won its place, in comparison with physical science and history, as a science full of problems as well as facts, a mental exercise of no mean order. It is not only to the classical student, but to the man of science, the economist, and the statesman, and Mr. Freshfield added, to the elector, that a just knowledge of geographical conditions may prove serviceable. The abysmal ignorance of the British Empire in large classes of our countrymen who are allowed a share in controlling its destinies is not the least of our national dangers. Dr. H. R. Mill delivered a lecture on the rainfall of the British Isles, and Mr. G. W. Palmer, of Clifton College, gave a lantern exhibition of a set of views of the Dora Baltea.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 12, 1908.—"The Natural Mechanism for evoking the Chemical Secretion of the Stomach." By J. S. **Edkins** and M. **Tweedy.** Communicated by Prof. E. H. Starling, F.R.S.

By a special method, elsewhere described, the authors were able to restrict the introduction of food material to definite portions of the stomach and intestine. It was therefore possible to test how these different regions behaved as channels for absorption, and what the comparative value of different food substances was in respect of the evoking of the chemical mechanism of secretion of gastric juice. The fundus of the stomach was found to be non-functional in absorption, the pyloric end of considerable value, and absorption in the duodenum also stimulated the fundus to secrete. It was observed that acid alone is but a slight stimulus; dextrin has a marked effect similar to that shown by dextrose and maltose. Commercial peptone and the meat extract devised by Herzen, of Geneva, were found most potent of the substances experimented on.

No evidence was found of any negative hormone passing into the circulation tending to inhibit gastric secretion. The pyloric end of the stomach and the duodenum are to be regarded as the normal channels of such absorption as liberates the gastric hormone. The fundus is definitely excluded.

Royal Microscopical Society, December 16, 1908.—Mr. Conrad Beck, vice-president, in the chair.—(1) A workshop microscope for the examination of opaque objects; (2) a simple method of illuminating opaque objects: J. E. **Stead.**—Mounting rotifers and Protista in Canada balsam: Rev. Eustace **Tozer.**

EDINBURGH.

Royal Society, December 21, 1908.—Prof. Crum Brown in the chair.—A photographic apparatus for automatically recording the readings of the scale and vernier of any instrument: Dr. J. R. **Milne.** The apparatus was a specialised form of camera. When the observer wished to make a reading he pressed a small lever, which set in motion the automatic mechanism. The shutter was first opened and closed, and then the plate was moved on a step so as to bring a fresh part of its surface into position. A 5-inch by 4-inch plate could in this way be covered with seventy small photographs of the scale and vernier, and these could be read off at leisure afterwards. Not only was the work of the observer much lightened, but his eyes were spared much fatigue, while a permanent record was obtained in which there could be no error due to bias or a mistake in reading. The author had used this camera for some time in connection with a polarimeter, and had found it of great advantage in recording the readings of the Nicol.—The friction at the extremities of a short bar subjected to a crushing load, and its influence upon the apparent compressive strength of the material: G. H. **Gulliver.** As regards the effect of the friction of the crushing plates upon the yield point of short compression specimens, it was found that with plates harder than the material under test the end friction caused an increase in the apparent yield-point stress. This increase was calculated approximately as 20 per cent. for wrought iron and mild steel, 20 per cent. for cast iron, and from 50 per cent. to 200 per cent. for stones, bricks, and concrete. These figures, except the first, might apply almost equally well to the crushing strength, but they required experimental verification. The corresponding inclinations of the surfaces of sliding were $-37°$ for wrought iron and steel, 36° for cast iron, and 27° to 18° for stone, &c. The first value was seldom obtained, but the others agreed fairly well with average experimental results. With the crushing plates of softer material than that under test, the lateral flow of the former diminished the apparent strength of the specimen. For stones crushed between lead plates the calculation indicated a strength from 0·35 to 0·15 of that obtained with iron or steel crushing plates. Experiment gave from 0·65 to 0·45 as the value of the ratio, but the specimens did not rupture by shearing in the manner contemplated in the theoretic discussion. The total crushing load of a short specimen of cast iron was increased by diminishing the length of the piece, but the crushing stress per unit area was simultaneously decreased.

January 4.—Dr. R. H. Traquair, F.R.S., in the chair.—The fossil Osmundaceæ, part iii.: Dr. R. **Kidston** and D. T. **Gwynne-Vaughan.** The paper contained a detailed description of three osmundacean fossils from the Permian of Russia. In the most important, *Thamnopteris Schlechtrudalii*, the protostele of the stem has a solid central mass of xylem. The most central tracheæ are short, vesicular and reticulate, and are regarded as being transitional to a parenchymatous pith. On leaving the stele the xylem of the leaf trace is oval in transverse section with a mesarch protoxylem, and on its way through the cortex it gradually changes into the adiaxially curved C-shaped trace of the Osmundaceæ. These changes are held to represent the phylogeny of the adiaxially curved C-shaped trace in general. The stem stele of the Zygopterideæ is held to be phylogenetically connected with that of the Osmundaceæ.—Supplementary report on the hydroids of the Scottish National Antarctic Expedition: James **Ritchie.** Twenty-five species, mostly from the sub-Antarctic and temperate seas, have been added to the list already recorded, bringing the total number of the species and varieties in the *Scotia* hydroid collection up to sixty-one. Several new forms were described, and the known ranges of distribution of many species have been considerably extended.

PARIS.

Academy of Sciences, January 4.—M. Bouchard in the chair.—Certain systems of linear differential equations: Gaston **Darboux.**—The possible danger of turning over in the steering of aëroplanes: L. F. **Bertin.** From an examination of the aëroplanes in current use the author comes to the conclusion that there is a real danger of the whole machine turning over, either by the action of the wind or by the lateral pressure caused by steering out of the straight line. It is pointed out that further experimental data are needed.—Prof. Zirkel was elected a correspondant in the section of mineralogy in place of the late Carl Klein.—The multiform integrals of algebraical differential equations of the first order: Pierre **Boutroux.**—Directed waves in wireless telegraphy: Albert **Turpain.** A reclamation of priority as regards the work of M. Blondel.—Polar magnetic storms and the aurora borealis: Kr. **Birkeland.** Reproductions of eleven photographs are given, in which the phenomena of the aurora are experimentally imitated.—Modifications of the difference of contact potential of two aqueous solutions of electrolytes under the action of a continuous current: M. **Chanoz.** The passage of a continuous current through the contact surface of two aqueous solutions of electrolytes, MR, M'R', is capable of modifying the difference of potential between the two liquids. This variation of potential produced depends, both for intensity and sign, not only on the nature of the solutions, but also on the direction of the passage of the current through the contact considered.—The influence of the quality of the lighting on the photographic reproduction of colour: J. **Thovert.**—The freezing of mixtures of water and soluble fatty acids: A. **Faucon.** Solutions of formic, acetic, and propionic acids were used. The freezing points of the eutectic mixtures with these three acids were $-48°$, $-27°$, and $-29°·4$ respectively, and no formation of any hydrate could be proved.—The density of methane and the atomic weight of carbon: George **Baume** and F. Louis **Perrot.** The gas was prepared by the action of water on methyl-magnesium iodide, and after washing purified by fractional distillation under reduced pressure. Air being appreciably soluble in liquid methane, special precautions were necessary to remove this impurity. The mean weight of the normal litre of methane was found to be 0·7168 gram. According to the method of reduction employed, the atomic weight of carbon from this density is deduced as 12·004 (Leduc), 12·005 (D. Berthelot), and 12·003 (P. A. Guye).—Concerning the atomic weight of silver: A. **Leduc.** A reply to some criticisms of M. Dubreuil.—The silicides of hydrogen: P. **Lebeau.** A large quantity of the gas produced by the action of hydrochloric acid on magnesium silicide was cooled with liquid air, and the compounds of silicon with hydrogen submitted to fractional distillation. Besides pure SiH_4, not inflammable in air, a gas the density of which (2·18) corresponded with Si_2H_6 was obtained. A third compound, isolated in small quantity, and characterised by its extreme inflammability in contact with air, is probably silico-ethylene, Si_2H_4. It is this substance which renders the impure silicon hydride spontaneously inflammable.—A case of isodimorphism: H. **Marais.** The forms of ethylamine chlorhydrate and bromhydrate stable at the ordinary temperature are perfectly isomorphous. The forms realisable at higher temperatures are isodimorphous, the stable form of one of the bodies being isomorphous with the unstable form of the other.—The hypotypical regeneration of the chelipeds in *Atya serrata*: Edmond **Bordage.**—Leprosy and demodex: A. **Borrel.**—The parthenogenetic segmentation of the egg in birds: A. **Lécaillon.**—The gastric digestion of casein: Louis **Gaucher.** Coagulation of the milk does not necessarily occur in the stomach, and is not peptonised in that organ.—The effect of bases on the action of certain ferments: C. **Gerber.**—A gravimetric method of constant sensibility for the measurement of high altitudes: Alphonse **Berget.** The apparent variation of the weight of a body, passing from one altitude to another, is proportional to the difference of level of the two stations. This variation is of the order of 1/10,000 for the height of the Eiffel Tower.—Rain and springs in Limousin in 1908: P. **Garrigou-Lagrange.**—The earthquake of December 28, 1908: Alfred **Angot.** A reproduction of the curve registered by the Milne seismograph at the Parc Saint-Maur Observatory is given.—The earthquake of December 28, 1908: R. **Cirera.** An account of observations made at Ebro.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 14.

ROYAL SOCIETY, at 4.30.—The Yielding of the Earth to Disturbing Forces: Prof. A. E. H. Love, F.R.S.—The Relation of the Earth's Free Precessional Nutation to its Resistance against Tidal Deformation: Prof. J. Larmor, Sec.R.S.—Notes on Observations of Sun and Stars in some British Stone Circles. Fourth Note. The Botallek Circles, St. Just, Cornwall: Sir Norman Lockyer, K.C.B., F.R.S.—On the Depression of the Filament of Maximum Velocity in a Stream flowing through an Open Channel: A. H. Gibson.—On the Passage of Röntgen Rays through Gases and Vapours: J. A. Crowther.—On the Velocity of the Cathode Rays ejected by Substances exposed to the γ-Rays of Radium: R. D. Kleeman.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The G. B. System from a Tramway Manager's Point of View: Stanley Clegg.

MATHEMATICAL SOCIETY, at 5.30.—The Canonical Form of a Linear Substitution: H. Hilton.—On the Solution of the Quintic: J. Hammond.—On Octavic and Sexdecimic Residuacity: Lieut.-Col. A. Cunningham.—On Change of the Variable in a Lebesgue Integral: Dr. E. W. Hobson.—On Abel's Extension of Taylor's Series: Rev. F. H. Jackson.—Note on the Evaluation of a Certain Integral containing Bessel's Functions: Prof. H. M. Macdonald.

FRIDAY, JANUARY 15.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Filtration and Purification of Water for Public Supply: John Don.

MONDAY, JANUARY 18.

ROYAL SOCIETY OF ARTS, at 8.—The Public Supply of Electric Power in the United Kingdom: G. L. Addenbrooke.

VICTORIA INSTITUTE, at 4.30.—Science and the Unseen: Dr. A. T. Schofield.

TUESDAY, JANUARY 19.

ROYAL INSTITUTION, at 3.—Albinism in Man: Prof. Karl Pearson, F.R.S.

ROYAL STATISTICAL SOCIETY, at 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion*: High Speed on Railway-curves: J. W. Spiller.—A Practical Method for the Improvement of Existing Railway-curves: W. H. Shortt.

WEDNESDAY, JANUARY 20.

ENTOMOLOGICAL SOCIETY, at 8.—Annual General Meeting.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Presidential Address, by Lord Avebury: On Seeds, with Special Reference to British Plants.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Annual General Meeting.—Address on Some Aims and Efforts of the Society: Dr. Hugh Robert Mill.

THURSDAY, JANUARY 21.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Syntonic Wireless Telegraphy, with Specimens of Large-scale Measurements: Sir O. Lodge, F.R.S., and Dr. Alex. Muirhead, F.R.S.—The Leakage of Helium from Radio-active Minerals: Hon. R. J. Strutt, F.R.S.—The Mobilities of the Ions produced by Röntgen Rays in Gases and Vapours: E. M. Wellisch.—On the Electricity of Rain and its Origin in Thunderstorms: George C. Simpson.—The Photo-electric Fatigue of Zinc, II.: H. Stanley Allen.

LINNEAN SOCIETY, at 8.—The Genus Nototriche, Turcz: Arthur W. Hill.—The Longitudinal Symmetry of Centrospermeæ: Dr. Percy Groom.

ROYAL INSTITUTION, at 3.—Mysteries of Metals: Prof. J. O. Arnold.

FRIDAY, JANUARY 22.

ROYAL INSTITUTION, at 9.—The World of Life: as Visualised and Interpreted by Darwinism: Alfred Russel Wallace, O.M., F.R.S.

PHYSICAL SOCIETY, at 5.

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