Education-England

THURSDAY, JULY 20, 1916.

THE FUTURE OF EDUCATION.

THE speech of Lord Haldane in the House of Lords on July 12, on the training of the nation and the necessity of preparing for the future, is a timely contribution to the momentous discussion of the question of the educational position of Great Britain, and especially of that portion of it identified with England. Our only regret is that while Lord Haldane was a member of the Government he did not see that decided steps were taken to remedy the defects to which he refers, and thus give us the strength needed to compete successfully in the rivalry of nations. When he was president of the British Science Guild he took an active part in asserting the claims of science and scientific education to fuller recognition by the State, and we looked naturally to the realisation of these aims when he was in office. Statesmen have yet to learn that it is their duty to lead the people, instead of waiting for a mandate from them. If industrialists have failed to take the fullest advantage of scientific knowledge and research, the omission is due largely to the indifferent attitude shown by the Government until recently towards these factors of modern progress.

Whilst giving due credit to the results of the Education Act of 1902, particularly in respect of its effect in improving the supply of secondary education, in breathing new life into the numerous endowed schools of the country, Lord Haldane is careful to point out that, despite the improvement which has been achieved, this feature of our educational system remains our weak spot. So long as the possibilities of secondary education continue to be, to so large an extent, undeveloped and unorganised, as regards number, accessibility, staff, and equipment, so long as most of the pupils in secondary schools do not remain after they are about fifteen years of age, the possibility of efficient and abundant university education remains an unrealised dream.

It is, Lord Haldane says, an appalling reflection that in this country 90 per cent. of our young people get no further education after the age of fourteen, not to speak of the many thousands who cease school attendance at a much earlier age, and he further states that between the ages of sixteen and twenty-five much more than five and a quarter millions get no further education at all. The number of students who enter the universities of England and Wales in each year is 18,000 from a population of 38 millions, whilst in Scotland, out of a population of four and three-quarter millions, the number who enter the universities annually is 7770. If, therefore, there was the same proportion of students to population entering the universities of England and Wales as in Scotland the number would be upwards of 57,000.

It may well be asked what chance have we against other nations which go on a different plan and thereby, to put the question on no higher plane, have the knowledge and the power to stimulate industrial capacity and activity. "What does education mean but the training of the whole nature in the widest and most comprehensive sense, so that the youth of the nation may be able when the time comes to turn, it might be to science, it might be to the humanities, or to any of the thousand and one subjects which are covered by the field of knowledge of the twentieth century?" It is an absurd travesty of the situation, in the controversy now going on as to the respective share of science and the humanities, especially the classics, in the sphere of education, to accuse the advocates of science of claiming that science shall have the dominating influence to the exclusion of the humanities. They plead that science and scientific training shall, having regard to the great advance in the knowledge of natural phenomena and of the constitution and potentialities of matter which has now been gained, and the great part which these discoveries now play in human activities and as contributories to human well-being, be accorded their due place in the scheme of education from the lowest to the highest grades and be accepted as an essential factor in the equipment of every educated man.

In defence of the attitude of scientific men on this question, we cannot do better than cite the words of Huxley, where he says:—

> Do not expect me to depreciate the earnest and enlightened pursuit of classical learning. I have not the least desire to speak ill of such occupations nor any sympathy with those who run them down. . . . Classical history is a great section of the palæontology of man, and I have the same double respect for it as for other kinds of palæontology—that is to say, a respect for the facts which it establishes as for all facts, and a still greater respect for it as a preparation for the discovery of a law of progress.

In addressing the students of the South London Working Men's College in 1868 he laments that—

> Literature is not upon the college programme, but I hope some day to see it there. For literature is the greatest of all sources of refined pleasure, and one of the greatest uses of a liberal education is to enable us to enjoy that pleasure. Education is the instruction of the intellect in the

laws of Nature, under which I include, not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and living desire to move in harmony with those laws. For me education means neither more nor less than this. Anything which professes to call itself education must be tried by this standard, and if it fails to stand the test, I will not call it education, whatever may be the force of authority or of numbers on the other side.

This is how the question stands to-day, and it will be strange—not to say tragical—if it be not possible for the leaders of the nation, in view of the tremendous issues which lie before us, to devise the means of solving it without further delay so as to set up as "the ideal of a national educational system an organisation giving every single individual a chance to attain to a maximum of personal culture and social efficiency according to his natural gifts and the strength of his will."

Lord Cromer, in a speech following Lord Haldane's, remarked of Germany that "side by side with a great advance in national prosperity and scientific knowledge there had been a vast deterioration of character"; and he feared the same moral collapse for us "if not sufficient attention was paid to humanistic, particularly classical, education in this country." The association of science with crass materialism, and the suggestion that we must look to classical education to preserve our national character, are both presumptuous and misleading. Lord Cromer must know that until after the year 1900 the only way of access to the university in Germany was through the Gymnasium with a nine years' Latin course and a six years' Greek course. It would be more accurate, therefore, to seek the origins of the present war and of German barbarisms in classical education rather than in that of science. The diplomatists and statesmen who are responsible for the war have, almost without exception, been trained on classical lines; and they have called in the aid of forces provided by science, which must, however, not be made responsible for the ignoble uses to which its knowledge is put. Men who have had a scientific education have answered their country's call, and made the supreme sacrifice, just as readily as those trained in classical schools. To suggest that the British nature and the noblest characteristics of "an English gentleman" must have the flimsy classical teaching of public schools to cultivate them is a fallacy which will not bear a moment's serious consideration.

Lord Cromer's speech is just such a one as might have been made in support of Latin as a humanising influence, when, at the Renaissance, the humanists of that time were urging the introduction of Greek into the curriculum. In those days the humanists were on the side of the new learning, but now they range themselves against it, forgetting that education must take account of the demands and tendencies of the day. When placing utilitarianism in contrast with literary studies, and science against spirituality, it should be borne in mind by advocates of established methods that, at the time when the foundations of classical education were laid, Latin and Greek had a very definite utilitarian object—one as the international language of the learned, the other as the storehouse of mathematical and scientific knowledge.

The time is ripe for a great and fundamental change in our methods and means of education. Modern needs demand not only that science and scientific training should be given their rightful and due place in the curricula of all grades of schools and in the universities, but also the abolition of all restrictions which prevent the children of the nation from the enjoyment of school-life until fourteen years of age. Part-time instruction should be arranged within the normal hours of labour for those who have left school until the end of the seventeenth year at least, and, lastly, the status and rewards of the teacher should be raised and made more attractive. The Promised Land is in sight, and must be won. It lies with our statesmen to give effect to these imperative claims and so provide for the best development of the Empire.

THEORY OF CALCULATION.

Theory of Measurements: a Manual for Physics Students. By Prof. J. S. Stephens. Pp. vii+81. (London: Constable and Co., Ltd., 1915.) Price 6*s*. net.

A NATURAL but erroneous impression produced by the title of this book, "Theory of Measurements: a Manual for Physics Students," is that it has to do with apparatus such as is found in a physical laboratory; but actually, while occasionally some piece of apparatus is just mentioned, the book has but little to do with physical apparatus or its use. Measurements are supposed already to have been made, and then the "theory of measurements" comes in, and considerations of accuracy, probability, least squares, and scientific juggling generally are set before the reader. It is difficult to say that they are explained; they are stated.

After a short introductory chapter, in which the extreme accuracy of wave-length observations are referred to and contrasted with a crude determination of *g* by means of an extemporised simple pendulum, with the view apparently of giving some idea of the use of significant figures, the author discusses in the next chapter the theory of probabilities, the weighting of observations, and the treatment of the figures obtained, but illustrations are deferred until after the chapter on the precision of observations. Some interesting subjects for discussion are appended. The last relates to gambling, and the views of Dr. Burnham, of Chicago, are quoted, who believed that if the laws of chance were taught to children in the schools, they would steer clear of the slot machine in early years, and later would shun the bookmaker and every other gambling magnate. Now, would they? Might not they, even though they had been taught that the value of the chance was only halt what they were paying, come to that other conclusion—natural if they have imperfectly understood what they were taught—that the laws of chance are "all theory like the stars," and that with luck they might easily win a big prize?

The third chapter is on "the adjustment of observations," and here we find more pains taken to explain how observations in general and observations that are not exactly consistent in particular should be dealt with to obtain the best or most likely results.

In the chapter on "the precision of observations" the probability curve is treated graphically, and mean square error, average deviation, and probable error are explained. The next chapter, on the propagation of errors, perhaps most nearly touches the experimental work of the student, for here the relation of error of observation to error of result is discussed. After this, plotting and negligibility are the subjects of two chapters, in the latter of which the slide rule is taken as an example. The concluding chapter is on empirical formulæ and constants.

It will be seen from the tabular statement of the subjects considered that they are of the first importance to the experimentalist. At the same time, unless the student is made to appreciate well both the niceties of the experimental art and the matters dealt with in this book, the latter may, if imperfectly understood, be a source of danger. The student may not appreciate the futility of overloading a multitude of bad observations, subject of necessity to consistent errors, with sheets of least square calculations. If he has more aptitude for figures than for experiment, he may even delude himself into believing that his calculated probable errors really are probable errors. In such cases it is much more important to spend the time required for these calculations in improving his apparatus or varying his method so as, so far as possible, to avoid consistent errors. Two or three experiments really well conducted are worth far more than a multitude performed in a slovenly way, and no scientific juggling will give the multitude more value. The writer feels that this aspect of the general question is not sufficiently insisted on, and the book, in spite of its many excellent features, would be more valuable to the student if the author had condescended to give more attention to the actual operations of the laboratory and their relation to the consequent calculations.

C. V. BOYS.

"SPOTTED FEVER."

Cerebro-spinal Fever. By Dr. Michael Foster and Dr. J. F. Gaskell. Pp. x+222. (Cambridge: At the University Press, 1916.) Price 12*s.* 6*d.* net.

THIS excellent and complete monograph of the much-dreaded disease, cerebro-spinal fever—dreaded because of its high mortality and incapacitating sequelæ—should prove of great interest not only to the members of the medical profession but to men of science generally.

The book is dedicated by the authors to the memory of their respective fathers, and on account of its careful, lucid, scientific, yet withal practical, exposition of the subject it is a worthy tribute to those two great founders of the modern school of English physiology.

The authors claim that this monograph has for its aim an attempt to bring together and correlate the clinical and pathological facts which they were enabled to accumulate during the epidemic of 1915 in the Eastern Command, and the views set forth are the outcome of clinical and pathological observations made in the wards, the laboratory, and the post-mortem room of the 1st Eastern General Hospital.

There are eleven chapters and two appendices, and the excellent plan of giving a summary in italics of the principal facts dealt with in each chapter is helpful to the reader. There are eleven excellent plates, eight of which are coloured. The work commences with an interesting historical account of the disease—largely a summary from the exhaustive treatise by Hirsch on Geographical and Historical Pathology. The first authentic account of an epidemic is that which occurred in Geneva in 1805. From the date of this, its first appearance, the disease was epidemic at various places both in Europe and America. Read in the light of modern knowlege of carriers in the propagation of disease, we can understand how this disease suddenly appeared and travelled according to no appreciable law.

Prior to 1915 cerebro-spinal fever in an epidemic form had been confined in Great Britain to the industrial centres of Scotland and Ireland. The authors point out that although the naso-pharynx is the location in which the specific organism is to be found, yet, according to their experience, it may be present without causing any marked inflammatory condition of the mucous membrane. Consequently, carriers may appear to be healthy persons; and it is not surprising, therefore, that when, in 1915, large numbers of soldiers were crowded into huts and billets with deficient ventilation and other favouring conditions, outbreaks of the disease should have occurred not only among the soldiers but also among civilians. Serious epidemics occurred at Salisbury Plain, Aldershot, in the London area, and in the eastern counties of England. A good account of the symptomatology, diagnosis, and treatment of the disease is given. Four excellent coloured plates illustrate the four distinct varieties of rash, and the statement of the authors may be noted that in their 39 cases a rash was present in 22.

The symptoms due to the inflammation of the meninges, viz., severe headache, vomiting, retraction of the head and neck, stiffness of the neck, and the presence of Kernig's sign, are common to all forms of meningitis. But the presence of the rash, and the discovery of the *Meningococcus (diplococcus) intracellularis* in the cerebro-spinal fluid after withdrawal by lumbar puncture, constitute the essential differential diagnostic signs. Excellent photographs are given illustrating cases exhibiting the head retraction and Kernig's sign; also remarkably well-executed coloured plates illustrating the macroscopic appearances presented by the brain and spinal cord, and the microscopic appearances of the meninges and the cerebro-spinal fluid containing the *diplococcus intracellularis*.

Various statistics are quoted which appear to prove that the authors are right in asserting that frequent lumbar puncture is the most valuable therapeutic measure, and that it is not enhanced by subsequent intrathecal injection of Flexner's serum. In fact, they state: "In our somewhat limited experience the introduction of serum caused, for the most part, a decided aggravation of cerebral symptoms." An excellent chapter on the pathology of the disease follows, in which the authors discuss the channels by which the diplococcus passes from the nasopharynx to the subarachnoid space. This is followed by a chapter on changes in the cerebrospinal fluid and the cultivation of the meningococcus from it, from the blood, and from the urine. The last fifty pages are devoted to an exhaustive account of the epidemiology and bacteriology, in which are discussed the contagion direct from throat to throat, the mode of examination of carriers, and their treatment by isolation and local applications to the throat and nose. In conclusion, there is an appendix containing a remarkable example of the spread of the meningococcus from carrier to carrier.

A MONOGRAPH ON TICKS.

Ticks. A Monograph of the Ixodoidea. Part iii. *The Genus Haemaphysalis.* By Prof. G. H. F. Nuttall and C. Warburton. October, 1915. Pp. xiii + 349–550 + plates viii–xiii. (Cambridge: At the University Press.) Price 12*s.* net.

Bibliography of the Ixodoidea. Part ii. May, 1915. By Prof. G. H. F. Nuttall and L. E. Robinson. Pp. 32. (Cambridge: At the University Press.) Price 4*s.* 6*d.* net.

THE present part of this useful monograph deals with the fifty species and varieties of Hæmaphysalis recognised as valid by the authors. The distinguishing features of the genus are stated and discussed, and the difficulty is noted of finding, among the many negative characters in this genus, points which can be employed for differentiating the species. Nevertheless, the authors have succeeded in drawing up a helpful dichotomic key for the determination of the species. The species are then considered in turn, and, as in the two previous parts of the monograph, careful drawings are given of those parts which are of systematic importance. Interesting conclusions are reached from a study of the geographical distribution of the different species; *e.g.*, that *H. bispinosa* has almost certainly been imported into East Africa, and possibly into New South Wales, with Indian cattle. Only one species of Hæmaphysalis appears to be restricted to birds, whereas several species of Ixodes are found only on birds. The authors give a list of hosts on which the various species of Hæmaphysalis have been found, and discuss the condemned and doubtful species. An account is given of all that is known regarding the biology of six species, two of which have been proved to be the carriers of pathogenic protozoa, one especially—*H. leachi*—being known in many parts of Africa as the carrier of a fatal disease—canine piroplasmosis or malignant jaundice.

The bibliography (462 titles) contains references to, and in many cases short notes on the nature and contents of, papers which for the most part have appeared since the publication of the previous bibliography in 1911.

OUR BOOKSHELF.

Newsholme's School Hygiene. The Laws of Health in relation to School Life. New edition, rewritten for all School Workers, by Dr. J. Kerr. Pp. 352. (London: G. Allen and Unwin, Ltd., n.d.) Price 4*s.* 6*d.* net.

NEWSHOLME'S text-book on school hygiene first appeared in 1887, and in 1912 it reached its thirteenth edition. That fact is sufficient evidence of the appreciation it has met with; but circumstances have not made it possible for Dr. Newsholme to continue to develop the work so as to keep it abreast of the rapid advance of the science of school hygiene and the extension of its practice which recent years have witnessed. Hence it became desirable that the text-book should be rewritten by one who, like Dr. James Kerr, has played a more prominent part in these developments. The result is a text-book possessing much merit, and embodying facts and opinions based upon a large amount of experience and research.

It seems from a perusal of the first paragraph that the book is more particularly designed for school-teachers, but to such it will be more satisfactory when Dr. Kerr is able in the next edition to bring his exceptional knowledge and experience to bear upon a fuller treatment of some matters of importance; for while the book is (generally speaking) well balanced in its treatment of the subject-matter, it is in places much too brief. To give two instances: The practical guidance upon the diet of the school child is very scant; and the subject of the disinfection of school books and papers demands something more than the statement (p. 345) that "any practical results of treatment of books or papers require so much care that destruction is probably the best treatment for such infected things." If this pronouncement is warranted by Dr. Kerr's experience, it stands in need of some amplification, if only in view of his subsequent statement (p. 346) with reference to scarlet fever and diphtheria that "no case is on record where school material has been demonstrated as the cause of spread." Part ii. of the book stands much in need of more and better illustrations.

The Daubeny Laboratory Register, 1904–1915. With Notes on the Teaching of Natural Philosophy, and with Lists of Scientific Researches Carried Out by Members of Magdalen College, Oxford. By R. T. Günther. Pp. x+139 to 295. (Oxford: Printed for the Subscribers at the University Press, 1916.) Price 7s. 6d. net.

IN this volume Mr. R. T. Günther, fellow and tutor of Magdalen College, has furnished a supplement to the register of workers in the college laboratory already published as an appendix to his "History of the Daubeny Laboratory." It is, as the compiler states, a record of quiet achievement by men who have been trained in the science schools of Oxford, and it may well be commended to the notice of those critics who are accustomed to speak as if the neglect of science were characteristic of Oxford at the present day.

The lists, though naturally of chief interest to Magdalen men, contain many names of members of other colleges who have laid the foundation of future distinction in the historic buildings by the Cherwell. Among the records here given are those of R. T. Reid (Lord Loreburn), F. Jeffrey Bell, G. T. Prior, J. B. Farmer, G. A. Buckmaster, A. F. S. Kent, F. C. R. Jourdain, J. A. Gardner, W. A. F. Balfour-Browne, C. G. Douglas, C. H. G. Martin (all members of Magdalen), Lazarus Fletcher (as Millard lecturer), and F. Soddy. The book also contains a list of apparatus bequeathed by Daubeny, of much historic interest.

Mr. Günther's labours have not been confined to the mere preparation of lists and enumeration of alterations and enlargements. He has given incidental expression to views on the position of science in Oxford, which, as coming from a teacher of experience and success, deserve serious consideration. Many would agree with him that the ultimate success of students is not to be estimated by the awards of examiners. More questionable, perhaps, is his opinion that the establishment of the final honour schools early in the last century, engineered by a party in favour of one form of learning, exerted a sinister influence on other studies, including natural science.

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.]*

Gravitation and Temperature.

As one had anticipated, Dr. P. E. Shaw has been well aware (NATURE, July 13, p. 401) of the surprising character of the conclusions to which his very refined and searching experimental investigation on the relation of gravitation to temperature had led him, and has recognised the possibility of other obscure causes being in operation.

He steers clear of collision with awkward facts, with much success, by the hypothesis that the gravitation between two masses depends, not on their individual temperatures, but on a mean temperature of the pair, the mean being reckoned in any way that makes the larger mass preponderant.

This hypothesis does, of course, set aside the Newtonian principle of mutual forces. For example, that principle postulates independent mutual attraction between every two elements of mass, unchanged by the nature or temperature of any material obstacle that may intervene between them: every delicate operation of weighing invokes this principle. Yet here the total amount of heat in the attracting pair, or something of that sort, is held to affect their attraction, while intervening obstacles are of no account.

Theoretical considerations are, of course, rarely competent absolutely to rule out a new phenomenon, however strange, provided it is on a small enough scale; their function is to make an analysis into its essential elements, and to formulate the points to be tested in order to arrive at rejection, or incorporation with existing theory. The main surprise in the present case is the very high value for an influence of temperature on gravitation that is obtained.

Cambridge, July 5. J. L.

The Great Aurora of June 17, 1915.

REGARDING the magnetic storm and the auroral display of June 17, 1915, referred to by Prof. Barnard and Father A. L. Cortie (see NATURE, vol. xcv., pp. 450, 536, etc.), it may be of interest to place on record the following facts. Independent reports presented by Mr. Tulloch, the meteorological observer, and Mr. Henderson, the wireless operator, at Macquarie Island, lat. 55° S., each mention the Aurora Australis of that date as the most brilliant noted in periods of one year and two years respectively. It was also the only occasion in two years when it was absolutely impossible to receive signals from any other station—even the high-power plant at Awanui, near Auckland (New Zealand), which seldom failed to make itself heard.

Mr. Tulloch's reports for three days were as follows:—

June 16, 9 p.m.—Barometer (corrected) 28·460 in., temperature 37·4° F., wind N.N.W., force 5 (Beaufort scale). Fierce gales in morning; fine clear night; slight auroral glow in the south.

June 17, 9 p.m.—Barometer 29·361 in., temperature 27·0° F., wind S.W., 7. Snowstorms continued throughout the day; three inches of snow on the ground. Squally S.W. winds and high seas. Barometer rising rapidly.

Brilliant red aurora. Looked something like a Japanese fan opening and closing. Its centre or base was a little north of the zenith and spread out from about E.S.E. to W.N.W. The colours varied from bright green and purple to a deep red round the edges. The display continued all the evening, and at 10 p.m. it worked to the N.N.W., appearing to reach the northern horizon.

June 18, 9 p.m.—Barometer 29·658 in., temperature 27·8° F., wind S.W., 9. Snowstorms throughout the day with fierce S.W. gales. Brilliant aurora visible between breaks in the clouds.

Mr. Henderson reports:—

June 16, 8.40 p.m.—Very pale glow low down to the south.

June 17, 5.30 to 5.40 p.m.—Very vivid blanket form of aurora in the zenith, then a large red bank to the north-east very low and close, and red to the north; red fades and glow remains.

10 p.m.—Streamers and blanket form, and ring to the west and north.

The "atmospherics" heard in the wireless receiver varied in strength from 0 to 5 at intervals of about thirty minutes.

June 18, 9.20 p.m.—Sky nearly overcast, but bright glow visible overhead for a few minutes.

Although the auroral and wireless data appear to lack correlation, it may be of interest to note the circumstances under which the long and short waves (2000 m. and 600 m.) from Awanui, near Auckland, were received at Macquarie Island.

Of the six nights when both wave-lengths were recorded, the 600-metre wave was much the stronger on three nights when no aurora was seen; on two nights when the aurora was reported the longer wave-length was the stronger. On the remaining night the longer wave was again the stronger, but the sky was overcast and the moon approaching the full. An aurora, if there had been one, could scarcely have been seen in the circumstances.

H. A. HUNT
(*Commonwealth Meteorologist*).

Meteorological Bureau, Central Office,
Melbourne, May 24.

The Utilisation of Waste Heat for Agriculture.

IN the cheap generation of electricity the great problem must be how to secure and utilise by-products. With steam-driven stations the chief by-product is an abundant supply of hot water from the condensers, which in this country is looked upon as a nuisance to be got rid of as easily as possible. Would it not be possible to make use of this low-grade heat for agricultural purposes, so supplementing our all too scanty summers?

Power-houses burning 1000 tons of coal and upwards per week are quite common, and something like half of the heat generated by the coal is absorbed by the condensing water. It might be possible to heat fields by running the warm water through ditches, or perhaps better results would be obtained by running it through pipes buried in the ground. By this means large areas of land might be stimulated to produce much greater crops than have hitherto been found possible. It may be urged that the majority of existing power-houses are not in agricultural districts, so that the proposed experiment is not possible except in a few cases. To this one may reply that, in the near future, many large stations will be put down to supply current in bulk to vast areas. With the high voltage used for them the location of the power-house becomes a matter of wide choice, and it would be possible to put them in agricultural districts if this should prove financially worth while. The views of readers of NATURE on this point would be of interest.

C. TURNBULL.

Electricity Works, Tynemouth, June 29.

SCIENTIFIC HORTICULTURE.[1]

THE periodic reports of the experiments conducted by the Duke of Bedford and Mr. Spencer Pickering at Woburn are always sure of a warm welcome by scientific horticulturists. It is true that these reports often give rise to controversy, and sometimes disturb the tranquillity of established horticultural belief; but if horticulture is to be a progressive craft both controversy and loss of tranquillity are to be welcomed.

The present (fifteenth) report covers a wide area of ground and records the results of observation and experiment on many subjects of importance to the fruit-grower. Among these subjects are: the fruiting of trees in consecutive seasons, injury to tree-roots in planting, ramming the roots of trees at planting-time, modes of planting and pruning. The observations on the alternation of fruitfulness and relative unfruitfulness support in a measure the view commonly held by fruit-growers that such an alternation exists, although the authors are inclined to attribute it rather to the effect of external conditions—for example, spring frosts—than to an internal rhythm.

For our part, we are convinced that if the alternation is to be ascribed—as in fact it may well be—to external conditions, those conditions are more subtle and complex than the authors' hypothesis suggests. As to the fact of alternate fruitfulness and barrenness exhibited by certain varieties of apple there can be no doubt. One of the most striking examples was published some years ago by the Dominion Horticulturist (Canada), and was cited in the *Gardeners' Chronicle*. The numbers are so remarkable that they may be repeated here. A single tree of the apple Wealthy yielded the following amounts of fruit:—

Year	10th	11th	12th	13th	14th	15th	16th
Gallons of fruit	33	0	52	2	93	0	111

Year	17th	18th	19th	20th	21st	22nd
Gallons of fruit	22	96½	1½	75	5	118

Such a record establishes the fact of alternation of fruitfulness once for all, and it is the business of the scientific horticulturist to discover the explanation why certain varieties exhibit this alternation and why others do not.

Although we are far from being able to give a sufficient explanation of this alternate fruitfulness and barrenness, yet it is by no means impossible to see the direction in which the explanation is to be sought.

Kleb's brilliant investigations show that the nature and amount of the raw and elaborated food materials at the disposal of a plant determine the formation of vegetative or reproductive tissues. In such fruit-trees as the apple the blossom buds are laid down early in the preceding year. If at the period of their development there is a large demand on the part of the setting and maturing fruit for certain food materials, and if the supply

[1] Woburn Experimental Fruit Farm. Fifteenth Report. Pp. 83. (London: Amalgamated Press, Ltd., 1916.) Price 2*s.* 3*d.*

of those materials is limited, the blossom buds may have to go short. This effect of one year will be manifested in the poverty either of blossom or of fruit—or both—in the following year.

The sequence of barrenness on fruitfulness is, of course, not confined to fruit-trees, but is of common occurrence in forest-trees also. It is to be hoped that this interesting inquiry will be pursued at Woburn, and that a more precise expression may be given to the somewhat sketchy views with which we have at present to content ourselves. In an earlier report (the ninth) the authors startled orthodox fruit-growers by announcing that the practice of trimming tree-roots before planting is a work of supererogation, and that trees planted with bruised (untrimmed) roots do rather better than those with which this trouble is taken. The experiments described in this report tend rather to point away from the conclusions reached earlier, for they indicate—in the case of apples, pears, and plums—that root-trimming shows a balance in its favour of 15 per cent. In another experiment (with apples) there was no advantage either way; but with bush fruits (red currants and gooseberries) the untrimmed showed an advantage of 16 per cent. in the former case and 5 per cent. in the latter.

It must, we think, be conceded that the authors have established their contention that root-trimming is unnecessary. Growers are conservative and will doubtless need further convincing. In America, however, fruit-growers appear to share the authors' view, for in the most recent work on the apple (by Mr. Albert E. Wilkinson) we read that the leaving "of clean cuts is not being emphasised so much as formerly." It is noteworthy in this connection that in the southern States what is known as the Stringfellow method of root-pruning is practised. In this system all the roots are removed at planting and only small stubs left.

Further experiments on "careless" *versus* "careful" planting, in which the roots are either bundled in or spread out carefully, lead the authors to conclude that the careful method is unnecessary. They hold also to their previously expressed conclusion that ramming the roots is beneficial to the growth of the tree. We do not remember whether the experiment has been tried under the somewhat drastic conditions of pot-cultivation—the pots would need to be strong—but we are inclined to think that only by some such means may this point of practice be established beyond cavil. All are agreed that firm planting is necessary; the point on which growers are not at present convinced is the beneficent effect produced by such drastic ramming as is likely to injure the roots.

In expressing our gratitude to the authors for their valuable researches we would venture on the suggestion that the time has come for the publication of a full summary of the work at Woburn.

F. K.

THE ORGANISATION OF BRITISH CHEMICAL INDUSTRIES.

The term "chemical industry" includes so many diverse interests, many of which are relatively small, that hitherto no joint action has been possible, and the smaller firms in particular have not been in a position to take advantage of the modern progress of science. There has been intense competition between neighbouring firms, and consequently great secrecy as to methods and results. All this must be changed in the future if the competition of enemy and friendly States is to be met successfully; British firms with kindred interests must unite and pool their resources instead of competing. The position to-day of those branches of the chemical industry which are highly organised shows that foreign competition can be encountered and defeated, and that the knowledge how to organise for success is not lacking in this country.

The formation of an association of British chemical manufacturers under the auspices of the most progressive chemical manufacturing firms in the country is undoubtedly an event of the deepest significance for the welfare of the industry. At a meeting held in London on June 22 a draft constitution and rules were approved, and the following provisional committee elected:—

Dr. E. F. Armstrong (Joseph Crosfield and Sons), F. W. Brock (Brunner, Mond and Co.), Dr. Charles Carpenter (South Metropolitan Gas Co.), Dr. M. O. Forster, F.R.S. (British Dyes), J. Gray (Lever Bros.), C. A. Hill (The British Drug Houses), N. Holden (Hardman and Holden), C. P. Merriam (British Xylonite Co.), the Rt. Hon. Sir Alfred Mond, Bart., P.C., M.P. (Mond Nickel Co.), Max Muspratt (United Alkali Co.), Sir William Pearce, M.P. (Spencer, Chapman and Messel), R. G. Perry (Chance and Hunt), R. D. Pullar (Pullar's Dye Works), Dr. Alfred Ree (Society of Dyers and Colourists), A. T. Smith (Castner-Kellner Co.), the Rt. Hon. J. W. Wilson (Albright and Wilson).

The objects of the new body are very comprehensive. Broadly, the association aims to represent the chemical industry when dealing with the Government, to develop technical organisation, and to promote new industries and the extension of existing ones. In addition to the usual powers taken by trade associations, the objects enumerated include the promotion of industrial research, the encouragement of the sympathetic association of manufacturers with the various universities and teaching institutes, and the co-operation with any society having for its object industrial efficiency or the advancement of applied chemistry. The names of the members of the committee are a guarantee that the scientific side of the work of the new association will not be neglected, and, moreover, provision is made for co-opting to the committee four representatives of allied associations, such, for example, as the scientific societies.

The subscription, which is based *pro rata* on the size of the subscribing undertakings, is sufficiently large to ensure that the association, if successful, will have ample funds at its disposal.

It is generally admitted that much remains to be done to bring about closer co-operation between science and industry, and it is therefore satisfactory to note that the new association proposes to arrange systematic conferences between manufacturers and teachers, at which the methods of teaching and the production of the particular type of trained man which manufacturers desire for their laboratories and works can be discussed.

PRINCE BORIS GALITZINE, For.Mem.R.S.

PRINCE BORIS BORISOVITCH GALITZINE died at Petrograd, after a short illness, on May 4/17 of this year, at the early age of fifty-four years. At the time of his death he was director of the meteorological service of the Russian Empire, which has its centre, in the winter, at the Nicholas Central Observatory, Petrograd, and, in the summer, at the Constantine Observatory at Pavlovsk, about twenty miles away. For that appointment he was chosen by the Imperial Academy in succession to Lieut.-General Rykatcheff, who retired in 1913 after many years' service.

Before his appointment he was a member of the Academy, to which he was appointed in 1894, sometimes acting as secretary, a professor in the University of Petrograd, and in charge of the seismological station at Pulkovo, which had been initiated by him, with the co-operation of Prof. Backlund, in November, 1906.

Born at Petrograd on February 18, 1862 (O.S.), Prince Galitzine was brought up at first abroad, and spent the eight years, 1880-1887, as a naval officer; he graduated in philosophy at Strasburg in 1890, and became Privatdocent in Moscow, and afterwards professor of physics in Jurjef, before his promotion to Petrograd in 1893. His earlier scientific papers were chiefly on the properties of gases and liquids, and the critical state, but his work covered also other branches of general physics. So early as 1887 he published, with General Rykatcheff, a handbook of meteorology, and later he organised, carried out, and reported upon the observation of clouds and other meteorological and hydrographical observations of the expedition of the Imperial Academy of Sciences to Nova Zembla in 1896.

He is, however, best known for his work in seismology, in which department of science he was a distinguished leader. He was elected president of the International Seismological Association at the meeting at Manchester in 1912. He designed the instruments which go by his name, and which are recognised as giving records specially adapted for the analysis of the various displacements of the solid earth, transmitted in the form of earthquake waves from one point to another of the globe.

A complete set of instruments of this type was presented by Prof. Schuster to the observatory at Eskdalemuir—the pair of horizontal recorders in 1911, and the vertical recorder in 1912. Prince Galitzine came to England with his wife in 1911, and made use of the opportunity to visit Eskdalemuir and supervise the erection of the horizontal pendulums there. Thereafter he took a paternal interest in the observatory. He visited it again at the time of the meeting of the International Association in 1912, and in the same year he gave a remarkable address to the meeting of the International Mathematical Association at Cambridge.

He received the degree of Sc.D. from the University of Manchester in 1911, and was only recently elected a foreign member of the Royal Society. His untimely death will be felt as a great loss by all who are interested in meteorological and geophysical subjects. His genius was undoubted. His energy and goodwill inspired confidence and commanded success.

NAPIER SHAW.

NOTES.

WE notice with very deep regret the announcement that Prof. E. Metchnikoff, foreign member of the Royal Society, died at the Pasteur Institute, Paris, on July 15, at seventy-one years of age.

THE death of Mrs. McKenny Hughes, wife of the Woodwardian Professor of Geology in the University of Cambridge, which occurred on the 9th of this month, will be widely regretted. She was the constant companion of her husband in his geological expeditions, not only in Great Britain, but also so far as to the Caucasus and western America, which they visited after meetings of the Geological Congress in Russia and in the United States. She took a keen interest in natural history, was a lover of flowers, especially the Alpine kinds, as was shown by the charming garden at their house in Cambridge, and had great artistic tastes, sketching admirably in water-colours. Sharing her husband's interests in geology and archæology, she joined him in writing the volume on Cambridgeshire in the "Cambridge County Geographies," and her hand may be seen in two drawings illustrating his paper on the Cae Gwyn cave in the forty-fourth volume of the Geological Society's Quarterly Journal. She made the mollusca, recent and subfossil, her special study, determining those found in that cave, and contributing an excellent paper on the subfossil contents of some Cambridgeshire gravels to the *Geological Magazine* for 1888. Her death takes away from Cambridge a lady of rare attractiveness and most valuable as a social influence, for she never flagged in helping her husband to make young geologists feel, as they passed through the University, that, great as was her love for the inmates of her home, she could yet find a place for them.

ECONOMICS has suffered a serious loss in the death of Capt. W. J. Mason, who was killed in action on July 3. Although only twenty-seven years of age, Capt. Mason, without contributing to the literature of economics, was making his influence felt, both as a lecturer and as a member of that rising school of economists which is devoting its attention to the social aspects and living problems of the science. Capt. Mason, whose experience was unusually wide, having been an examiner in the Exchequer and Audit Department, after a distinguished academic career at the London School of Economics, where he obtained both the Gerstenberg scholarship in 1911 and the

Gladstone prize, held for a time the position of tutor under the Workers' Educational Association, and afterwards accepted a lectureship at the University of Bristol, where he found that combination of learning and industrialism which naturally appealed to a man of his inclinations and ability.

THE issue of *Science* for June 23 last publishes the text of a Bill introduced by Mr. Newlands last March in the Senate of the United States, the object of which is to establish engineering experiment stations in the State colleges of the United States. The Bill was read twice, and has been referred to the Committee of the Senate on Agriculture and Forestry. The Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science has passed a resolution recommending the passage of the Bill, and emphasising the untold value to American agriculture of the similar agricultural experiment stations already established by the State in connection with the colleges. The Bill provides that "in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with engineering and the other branches of the mechanic arts, and to promote the scientific investigation and experiment respecting the principles and applications of the mechanic arts," there shall be established under the direction of the State college in each State a department to be known as an "engineering" or a "mechanic arts" experiment station. The Bill provides also for a grant of 3000*l.* a year to each State for the purposes of such an experiment station. It is worthy of note in this connection that, according to the *Scientific Monthly*, these State, or land grant, colleges and the institutions of which they are a part received in 1914, from the United States, 500,000*l.*; from the States and from other sources, more than 6,000,000*l.* They have 9000 instructors and 105,000 students.

ANOTHER attempt is being made to rescue the stranded Antarctic explorers on Elephant Island. Last week Sir Ernest Shackleton left Punta Arenas in an auxiliary motor schooner of 70 tons, placed at his disposal by the British settlers in the Magellan Straits. The vessel was to be towed south so far as possible by a steamer lent by the Chilian Government. The prospects of a rescue are considerably better than in the attempt made in the *Instituto Pesca*, for the *Emma* is a wooden vessel, and so better suited for the work. Moreover, the probability of open water up to Elephant Island is greater this month than last, when the ice conditions were exceptionally severe. There is, however, a possibility of failure, for the vessel has not power to force her way into pack-ice, and as no time must be lost in effecting a rescue of Wild and his men, arrangements have been made by the British Government to dispatch a relief ship from this country without further delay. Meanwhile, the *Aurora* is being repaired by the New Zealand Government, and will leave Dunedin in December under the command of Mr. Stenhouse, her first officer, to fetch Mackintosh and his party at Cape Royds. There is no likelihood that the *Aurora* will find any difficulty in penetrating the Ross Sea, or that the men at Cape Royds are in serious straits.

THE Athens correspondent of the *Times* reports that a decree has been published whereby from 4 a.m. on July 28 Greece will adopt East European time, and will thus be two hours in advance of Greenwich mean time, and one hour in advance of Summer Time.

THE *Indian Forester* records with great regret the death in action (in Flanders) of 2nd Lieut. G. R. Jeffery, deputy conservator of forests, Burma. We learn that Mr. Jeffery was born on December 12, 1880, educated at Coopers Hill, and joined the Imperial Forest Service in 1902. He was a man of high ability and professional knowledge, and his death will be a serious loss to the Forest Department.

ON August 24–26 the third annual conference of the Society for Practical Astronomy will be held at the Bausch and Lomb Observatory in Rochester, N.Y. The president of the society, Mr. L. J. Wilson, extends the invitation to the meeting to all who are interested in astronomy. The observatory at which the meeting will be held is equipped with an 11-in. refractor constructed by the Bausch and Lomb Optical Company.

DR. J. C. TELLO, Mr. G. K. Noble, and Dr. L. S. Moss have left New York on a South American expedition on behalf of the Harvard Museum of Comparative Anatomy. Arriving at Paita, in Peru, they will travel on mules across the Andes and into the Amazon Valley, where they hope to collect zoological specimens and to study the tribe of Guanani Indians.

AN important ethnological expedition is about to be undertaken by Dr. R. H. Lowie, of the American Museum of Natural History. He will visit, first, the Crow Reservation in southern Montana, where he hopes to secure a thorough-going account of the war customs of the tribe and to complete a collection of myths and folk-tales. After spending a short time with the Arapaho, of Wind River, Wyoming, in order to re-examine their ceremonial organisations, Dr. Lowie will proceed to northern Arizona, where an investigation of certain problems connected with the Hopi will be carried out in considerable detail. The main points of inquiry will be the character and functions of the Hopi medicine-man, and the nature of the religious feelings underlying the ceremonial performances already noted by previous observers.

THE President of the Board of Agriculture and Fisheries has appointed Mr. Richard Brown, Walton Bank, Eccleshall, Staffordshire, to be a member of the Agricultural Consultative Committee.

THE wireless station on Dickson Island was to have been dismantled, but thanks to the timely and enlightened intervention of the Russian Naval Ministry, which is providing the necessary funds, its existence is saved, and it will be able to carry on work, not only of great scientific value, but also of practical utility for Arctic navigation, which is just now of special importance for Russia.

THE Prime Minister has appointed a Committee to consider the commercial and industrial policy to be adopted after the war, with special reference to the conclusions reached at the Economic Conference of the Allies, and to the following questions:—(*a*) What industries are essential to the future safety of the nation; and what steps should be taken to maintain or establish them. (*b*) What steps should be taken to recover home and foreign trade lost during the war, and to secure new markets. (*c*) To what extent and by what means the resources of the Empire should and can be developed. (*d*) To what extent and by what means the sources of supply within the Empire can be prevented from falling under foreign control. The Committee is composed as follows:—The Right Hon. Lord Balfour of Burleigh, K.T., G.C.M.G. (chairman), Mr. Arthur Balfour, Mr. H. Gosling, Mr. W. A. S. Hewins, M.P., Mr. A. H. Illingworth, M.P., Sir J. P. Maclay, Bt., the Right Hon. Sir A. Mond, Bt., M.P., Mr. Arthur Pease, Mr. R. E. Prothero, M.P., Sir Frederick H. Smith, Bt., Mr. G. J. Wardle, M.P., together with the following gentlemen, who are presiding over the Board of Trade Committees on the position of important industries after the war:—Sir H. Birchenough, K.C.M.G., Lord Faringdon, Sir C. G. Hyde, the Hon. Sir C. A. Parsons, K.C.B., F.R.S., Lord Rhondda, and Mr. G. Scoby-Smith. Mr. Percy Ashley, of the Board of Trade, and Mr. G. C. Upcott, of the Treasury, have been appointed secretaries to the Committee.

FOR the first half of the present summer there has been a complete absence of seasonable weather, the conditions continuing most persistently dull, damp, and cool. The weather reports from the health resorts issued each day by the Meteorological Office scarcely show a temperature of 70° at any of the English stations. Very little sunshine has been registered, although the amounts are somewhat erratic, but the sun's rays have had little effect in raising the shade temperature. Since the commencement of the summer the amount of the rainfall is given separately for night and day, a matter of considerable interest, both scientifically and to the general public. Records are published from rather more than thirty English health resorts, but the June values are only complete for every day throughout the month from six stations. The night observations are covered by the Summer Time hours from 5 p.m. to 9 a.m., a period of sixteen hours, and the day from 9 a.m. to 5 p.m., a period of eight hours, so that the night period is double the length of the day. Notwithstanding that the day is only one-half the duration of the night the rainfall for the day is more than that for the night at all the six stations, except at Ramsgate, where it is only 32 per cent. of the total fall. At Felixstowe the day fall is 64 per cent. of the total; in London it is 62 per cent.; at Harrogate 61 per cent.; Worthing 59 per cent.; and at Leamington Spa 51 per cent. of the total rainfall. This great excess during the day is abnormal.

THE names Hurter and Driffield (more familiarly "H. and D.") will be remembered as long as photography is studied, on account of the results of many years' work which they published about twenty-six years ago. Dr. Hurter, a Swiss, was the chief chemist, and Mr. Driffield the engineer, at Messrs. Gaskell, Deacon and Co.'s, of Widnes, now the United Alkali Company, and in their spare time they worked together on some of the fundamental problems connected with photography with such success that their names will always be associated with the subjects that they investigated. Their methods of expressing the character of negatives and of estimating the sensitiveness of photographic plates, of which the present "H. and D. numbers" are living examples, form an important section of their work. The recent death of Mr. Driffield, seventeen years after the death of Dr. Hurter, has given rise to a strong desire to commemorate their work done in the advancement of photography. A committee of the Royal Photographic Society is therefore arranging a scheme to this end, and it is asking for subscriptions for the purposes of: (1) The endowment of an annual Hurter and Driffield memorial lecture. (2) The publication in book form of their most important writings, together with desirable but hitherto unpublished matter. (3) Providing suitable accommodation in the house of the Royal Photographic Society for the original apparatus, together with MSS., notebooks, correspondence, etc., all of which have been bequeathed to the society by Mr. Driffield and handed over to it by his executors. Several generous donations have already been acknowledged by the hon. treasurer, Mr. W. B. Ferguson, K.C., 48 Compayne Gardens, South Hampstead, N.W.

IN the Journal of the College of Science, Imperial University of Tokyo, for October, 1915, which has only recently been received, Mr. R. Torii publishes an elaborate article on the prehistoric population of Southern Manchuria. This paper, well furnished with photographs, describes a population of hunters and fishermen, who seem to have very slowly gained a knowledge of iron and were practically in the age of stone. The discoveries of flint implements were exceedingly numerous. The pottery with its decoration in encrusted nodules of clay, and often coloured in red, is particularly interesting. The clothing of these people consisted of skins with some textiles made of hemp and other fibres. In the kitchen middens in the neighbourhood of Port Arthur some decorative objects made of bronze, iron, and jade, probably imported, were found. Southern Manchuria offers a practically unworked field for archæological work, and the Japanese scholars who have undertaken the work of exploration may be trusted to make the best use of this favourable opportunity.

A GOOD illustration of the direct relation which obtains between the play of animals and the vital activities of life, such as the capture of agile prey, the avoidance of their most formidable enemies, or conflict with rivals, is furnished by Mr. C. J. Carroll in the *Irish Naturalist* for May. Herein he describes the behaviour of the raven when attacked by the peregrine. On such occasions every effort is made to escape by flight, but if overtaken the pursued throws himself on his back, and opposes beak and claws to his pursuer, thus, time after time, beating off the attacker. So soon as the young of the raven are able to fly the parents put them through a course of training in these tactics, acting the *rôle* of the peregrine until efficiency is attained. "At first the young are stupid and clumsy, but they soon learn to avoid the onslaught by turning over and presenting their claws, or by rising high in the air."

MR. J. H. OWEN, in *British Birds* for July, continues his record of observations made on the nesting habits of the sparrow-hawk. In the present section he describes the behaviour of the hen at the nest, bringing out some extremely interesting facts. Thus, for example, he remarks that when the young hatch she does not take the egg-shells to a distance and drop them, as so many other birds do, but eats them while she broods. Great attention is paid to the sanitation of the nest, the fæces of the very young birds being carefully gathered up, and either swallowed, or thrown clear of the nest by a jerk of the head. Later they are able to eject them over the edge of the nest, and so relieve the mother of this task. Until the young are from twelve to fourteen days old all the food is brought to the nest by the male, who is promptly and unmistakably informed if he displays an excess of zeal in this matter. There is one point on which the author fails to make himself clear. This concerns his statement that as incubation proceeds the hen sheds down about the nest until, at hatching time, it is flecked with down, which is removed very soon after the young are hatched. Is this down naturally moulted or pulled out? Why is it allowed to accumulate, since it serves to direct attention to the nest, and why is it later so carefully removed?

THE annual volume of the Kew Bulletin for the year 1915 has only just been published, although the concluding part was issued on December 24. Several articles of economic importance will be found in the 438 pages comprising the volume. In particular, one on the gemination of coconuts, from which it appears that nuts taken from young trees may safely be planted; another on the species of Sansevieria, the source of bowstring hemp, with numerous figures; and a third on Iburu and Fundi, two cereals from Upper Guinea, deserve particular notice. Of papers dealing with systematic botany, those on South African Santalacaceæ, the genus Meconopsis, new tropical African species of Ficus, and the genus Phelipea, a remarkable parasitic genus containing three species, are among the more important contributions.

IN the Memoirs of the Department of Agriculture in India, vol. vii., No. 7, Mr. and Mrs. Howard and Mr. Khan contribute important papers on the Indian oil seeds, safflower and mustard. As in the Howards' earlier investigations into the economic plants of India, the various races have been collected and carefully studied at Pusa. Twenty-four types of safflower, *Carthamnus tinctorius*, L., have been isolated and separated on the characters afforded by leaves, bracts, flower-colour, and general habit. As a dye plant the safflower has only local importance, but it is interesting to find that some of the types which yield most dye also yield a high oil content in the seeds. Improvement by selection could be undertaken with ease as a result of the work done at Pusa, though it may not be an easy matter to establish a superior variety on a large scale. Not only may it be difficult to replace the country crop, but owing to the frequency of natural crossing in the plant, the deterioration of an improved variety would be very liable to take place.

SEVERAL important publications have been received from the Norwegian Meteorological Institute. The Jahrbuch for 1915 contains a summary of the meteorological observations of all the stations in Norway for the year 1915, including the station at Green Harbour, in Spitsbergen, which is maintained in that no man's land by the Norwegian Government. This station, in 78° 2′ N., is the most northerly permanent observatory in the world. The annual volume on the rainfall of Norway ("Nedbøriagttagelser i Norge") gives the rainfall and snowfall for nearly 500 stations for the year 1915, and includes a large-scale rainfall map in two sheets. A further pamphlet ("Oversigt over luftens temperatur og nedbøren i Norge i advet 1914") gives the monthly mean temperatures and the rainfall for Norwegian stations, with their departure from the normal, in 1914.

THE May number of the Proceedings of the Tokio Mathematico-Physical Society contains a paper on the silver voltameter, by Mr. J. Obata, of the Department of Communications. In accordance with the specifications of the London conference of 1908 and of the Washington committee of 1910, the kathode was one of three platinum bowls, and the anode a plate of silver. After deposition the deposit was transferred from the bowl to the silver by electrolysis. Acidity of the silver nitrate solution was found to produce a decrease in the deposit of rather more than four parts in a million for an acidity near the kathode of one part in a million. With the help of two ohm coils previously standardised by comparison with the mercury ohm, the electromotive force of the normal Weston cell was found to be 1·01827 international volts at 20° C. The author recommends for ordinary laboratory work a silver voltameter in which anode and kathode are strips of silver bent into cylindrical hoops, the one of greater diameter being the kathode, placed in a glass dish, with a shallow glass dish below the anode to catch any particles of silver detached from it during the experiment.

IN the development of the sugar industry the saccharimeter has been a noteworthy factor, because of the accuracy and simplicity with which, by its aid, sugar and sugar-products can be evaluated. Moreover, in recent years the instrument has been increasingly used for the purposes of general scientific research. It is therefore important that any questions regarding the accuracy of the fundamental constants of the apparatus, and of sugar polarimetry in general, should be critically examined, and any uncertainty respecting the basis of standardisation removed. In No. 268 of the "Scientific Papers" issued by the United States Bureau of Standards an account is given of investigations carried out with this object in view by Messrs. Bates and Jackson, who have studied the "constants" of the quartz-wedge saccharimeter and the specific rotation of sucrose. They find that pure sugar gives a reading of only 99·89° for the normal solution, instead of 100° as hitherto accepted. In other words, the "100° sugar point" was found to be rather more than one-tenth of 1 per cent. too high, thus making the proportion of sugar in specimens tested with the saccharimeter too low by this amount. The authors' result, if confirmed, is important, not only to producers of sugar, but to fiscal authorities, inasmuch as sugar is assessed for duty by means of the saccharimeter. The specific rotation of sucrose in solutions of normal concentration was found to be 66·529°, light of wave-length 5892·5 Å being used; this is a slightly higher value than that generally accepted, namely 66·502°.

IN view of the abnormally high price of petrol and the difficulty of obtaining it, an article in the *Engineer* for July 7 will be read with interest. The article is descriptive of the Binks vaporiser and carburettor, by use of which paraffin may be substituted for petrol in motor-driven vehicles. A small petrol tank is fitted for the supply of petrol for starting the engine; paraffin is employed after the vaporiser has become sufficiently hot. The carburettor has two float chambers, one for petrol and the other for paraffin, and has a main jet and two pilot jets. The sprayed paraffin enters the vaporiser, which consists of two concentric tubes, between which the exhaust gases from the engine pass, and thus heat the walls of the inner tube. The latter tube contains a worm which causes the mixed air and paraffin to whirl as the mixture traverses the inner tube. There is thus a tendency to throw any unvaporised paraffin into contact with the hot walls, where vaporisation is completed. With present prices, application of this and similar devices may reduce the cost of fuel for motor-engines by 50 per cent.

THE following books of science are to be found in Mr. John Murray's new list of forthcoming books:—"David Gill: Man and Astronomer," by Prof. G. Forbes; "Man as He Is," by Sir B. Fuller; "The Ages of Man," by C. Sayle; "What is Instinct? Some Thoughts on Telepathy and Subconsciousness in Animals," by C. B. Newland; "British Forestry: its Present Position and Outlook after the War," by E. P. Stebbing; "The Lost Cities of Ceylon," by G. E. Mitton, illustrated; "A Book-Lover's Holidays in the Open," by T. Roosevelt, illustrated; "Form and Function: a Contribution to the History of Animal Morphology," by E. S. Russell, illustrated; "Hunting Pygmies," by Dr. W. E. Geil, illustrated; "Vegetable Fibres," by Dr. E. Goulding (Imperial Institute Handbooks); and new editions of "Recent Progress in the Study of Variation, Heredity, and Evolution," by Dr. R. H. Lock, revised by Dr. L. Doncaster, with a Biographical Note by B. S. Woolf (Mrs. R. H. Lock); and "The Study of Animal Life," by Prof. J. A. Thomson, illustrated.

OUR ASTRONOMICAL COLUMN.

ORIGIN OF GROUP G OF THE SOLAR SPECTRUM.—In a preliminary note presented at the June meeting of the Royal Astronomical Society, it was announced by Messrs. Newall, Baxandall, and Butler that the group of lines in the solar spectrum marked G by Fraunhofer had been proved by them to be mainly due to absorption corresponding with the hydrocarbon band about wave-length 4314. The band in question is well-known from its occurrence in the "candle-flame" spectrum, where it appears in association with the "Swan" bands, and Lockyer's work has shown that it is the characteristic band of the spectra of undissociated hydrocarbons. The conspicuous presence of the band in the Fraunhofer spectrum is in striking contrast with its absence from the spectrum of the chromosphere as photographed during total eclipses, and further investigation of the details, which is in progress at the Solar Physics Observatory, will probably throw light on this important difference. The discovery of the origin of the G group will doubtless also be of considerable importance in connection with the interpretation of stellar spectra, as a gradual reduction in the intensity of the group on passing to stars hotter than the sun is a well-marked feature of the stellar sequence.

VARIABLE STELLAR SPECTRA.—In continuation of previous work on the spectra of Cepheid variable stars Mr. Harlow Shapley has recently obtained 150 spectrograms of representative stars of this class, using the 10-in. portrait lens and objective prism of the Mount Wilson Observatory (Proc. Nat. Acad. Sci., vol. ii., p. 208). The eleven stars investigated have periods ranging from nine hours to twenty-seven days, and include some well-known naked-eye variables, and some for which orbits have been computed from spectroscopic data. For some of the stars the place of greatest intensity of the general spectrum had already been observed to shift towards the blue on the approach of maximum luminosity, and it has now been proved in addition that the details of the spectra change with the phase of the variable, in accordance with the normal stellar sequence—that is, when the star is at maximum brightness, its spectrum corresponds to a higher stage of the spectral series than when at minimum. The change of spectrum was particularly easy of observation in the case of small dispersion spectra of the F type, where the variations in the relative intensities of $H\gamma$ and the G group were very marked; this is especially interesting in connection with the recent discovery that the G band is of hydrocarbon origin (see preceding note). As examples of the range of spectral variation the following may be noted:—δ Cephei, F2 to G3; RR Lyræ, B9 to F2; RT Aurigæ, A8 to G0. It is inferred that all Cepheids, including those of the cluster type, vary periodically in spectral class, as well as in magnitude and radial velocity.

A LARGE METEOR.—On July 8, at 11.59 p.m. G.M.T., a large meteor equal to Venus was seen at Bristol by Mr. Denning, and at Totteridge by Mrs. Wilson. The radiant point was at $22^\circ + 24^\circ$, and the height of the object was from 77 to 51 miles. Its luminous course was 120 miles long, and observed velocity 32 miles per second.

THE EXTRAORDINARY METEORIC SHOWER OF JUNE 28.—Mr. Denning has been endeavouring to collect observations of this event, but it seems to have been witnessed by very few persons. The sky was cloudy in the eastern counties of England, but all over the west, from Bournemouth to Fleetwood, the weather seems to have been favourable.

An observer living at Birmingham states that between 11 and 12 p.m. G.M.T. he saw nearly one hundred meteors, and that the radiant point was between the stars Eta and Zeta Ursæ Majoris. He describes the meteors as often dropping over the S.E. and E. horizon. They were frequently of a golden hue, with very short paths and moderately slow in their flight. Several of the larger meteors were bluish-white, and flashed out with startling suddenness and brilliancy, sufficient to render them visible through the cloud stratum which gathered in various parts of the sky.

Another observer at Bournemouth says that at 11 p.m. G.M.T. he noticed three bright meteors in about as many minutes, and that this rate of apparition appeared to be maintained until the early dawn.

This shower is certainly the richest which has been observed since the Leonid display of November, 1903, and being altogether unexpected and unknown increases its importance and makes it very desirable that it should be fully investigated. Possibly the orbit of some recent comet may be found to coincide with it. It is certainly curious that definite showers proceed from the same apparent radiant point in Quadrans on about January 2–3, March 27–30, June 28, and October 2, the intervals approximating three months.

NATIONAL INTEREST IN MINERAL RESOURCES.

THE United States Geological Survey has issued its usual series of bulletins dealing with the mineral production of America in the year 1914. As pointed out in the introductory section, this compilation is the thirty-third of the published reports of the Mineral Resources Division of the Geological Survey, and thus enables comparisons to be instituted extending over a third of a century. The series is, however, rendered of still greater interest owing to the inclusion in it of an article by G. O. Smith, director of the Survey, on "The Public Interest in Mineral Resources." It need scarcely be said that this is written entirely from the American point of view; at the same time, it is very largely applicable to conditions in this country, because, as is well known, America and Great Britain stand practically alone amongst the world's great mineral producers in their system of mineral ownership. Everywhere the mineral resources of a country have been recognised since Roman times as originally the property of the State, to be administered for the benefit of the nation at large. The fact that the actual exploitation of its mineral deposits by the State is an unsatisfactory arrangement has been pretty universally recognised; there are a few isolated examples of such exploitation, which may succeed here and there under abnormal conditions, and the German Empire has carried this method further than any other State, but even in that autocratically governed country, where the working community is treated as a well-drilled machine subservient absolutely to the will of the ruling classes, State-worked mines cannot be described as successful. Apart from this ineffective method of dealing with their mineral wealth, States can choose between two very different, but both highly efficient, principles. Most of the great Continental States adopt the mining concession principle; under this the State retains for all time its absolute ownership of the minerals, but grants concessions to individuals or corporations under which these are allowed to exploit the mineral deposits upon payment to the State of a definite proportion of the

mines and mineral resources

wealth so won in the shape of a royalty. This system is often described as a mineral lease, but the term is misleading, because a mineral deposit is a wasting asset, and cannot therefore be leased in the true sense of the word, which implies that the lessee should return his property to the lessor in unimpaired good condition at the expiry of the period of lease. The system may be more correctly described as a sale of the minerals as and when extracted, the purchase consideration taking the form of an annual royalty payment.

The other principle, adopted by the United States and by ourselves, is that of out-and-out alienation, from the very commencement, of the mineral deposit. With us this process of alienation has long been completed; in the United States it is still proceeding as fast as mineral deposits are discovered. The mode of tenure of the mineral deposits being, however, essentially the same, the greater part of Mr. Smith's remarks are perfectly applicable to conditions in this country. His point of view is indicated by two apt quotations, one from Gen. Halleck, who wrote in 1860, to the effect that mines "are by nature public property, and that they are to be used and regulated in such a way as to conduce most to the general interest of society." He also quotes Dr. R. W. Raymond, who, it may be remembered, gave evidence as to the American system of dealing with mineral lands before our 1889 Royal Commission on Mining Royalties, in which he showed that the policy which the United States had adopted, as best calculated to promote the national welfare, was "to get its mineral lands as soon as possible into private hands," and the quotation from Dr. Raymond's first report on mineral resources, written in 1868, is so particularly applicable to British conditions, and deserves so well the careful consideration of all interested—and who is not?—in our mineral resources, as to deserve reproduction here:—

"In view of these peculiar relations of mining, it is evident that Governments are, in a certain sense, trustees of the wealth stored in the mineral deposits of their realms—trustees for succeeding generations of their own citizens and for the world at large. It is not a matter of indifference to the citizens of this country whether our mining fields be ravaged and exhausted in one or even five centuries, when they might last a score."

At a moment like this, when we stand at the beginning of what promises to be an industrial struggle even more keen and bitter than the actual warfare to which we are now devoting all our national energies, those responsible for the government of Great Britain would assuredly do well to take some account of the huge wastage of our own national resources that is going on unchecked and almost unheeded, and to ask themselves with what measure of fidelity they are discharging their trusteeship.

Mr. Smith lays much stress upon the development that has taken place in every portion of the American mineral industry within the past thirty-three years, and upon the fact that the utilisation of these resources has resulted in a "higher standard of public service" by "giving all the workers a better opportunity to live a full life," this being, as he justly observes, "the ideal of democracy." He is a firm believer in the advantage of the system of alienation of mineral lands; as he says: "Both the past record and the present status of the mining industry show that the mineral resources of the United States possess largest public value in their indirect contribution to national development. . . . In fact, it may be easily shown that the State or nation will not be so much benefited through a direct royalty as through the indirect revenue gained by the establishment of a new industry, and by its influence on the neighbouring agricultural areas and the transportation systems to which the new traffic is tributary." He points out in some detail that the most equitable, as well as the most convenient, method of obtaining a direct return for the nation from its mineral wealth is by means of an income tax upon the profits realised by the miner; yet, as he is careful to add, "the public's direct share of the proceeds from mineral resources must not be so great as to affect unfavourably labor's opportunity or capital's incentive."

Few short articles have appeared within recent years that will better repay careful study by legislators and economists than will the article now before us. It needs neither justification nor corroboration; yet were such required, they may be found in most emphatic form in the statistical summary of the mineral production of the United States in 1914, issued simultaneously. To take only a few items, the production of the principal metals was:—

Pig iron	22,263,263	tons
Copper	1,150,137,192	lb.
Lead	512,994	short tons
Zinc	343,418	" "
Nickel	845,334	lb.
Gold	4,572,976	oz.
Silver	72,455,100	"

Amongst non-metallic minerals the most important are coal, of which the total output was 513,525,477 short tons, and petroleum, with a production of 265,762,535 barrels. The total value of the mineral production of the United States is given as the enormous sum of nearly 2115 millions of dollars (say about 440,000,000*l.*), amounting to 21.40 dollars (say 4*l.* 10*s.*) per head of the population; the latter has practically doubled since 1880, whilst the value of the mineral production has increased nearly sixfold. It would be difficult to show such vast progress in any other similar field of human industry, and, though due in the first place to the wonderful natural resources of the United States, credit must also be given to the enlightened spirit in which these resources have been utilised. Our conditions in this country are, of course, widely different, yet there is no reason why we too should not strive to utilise what we have to the uttermost. Our need in this country is to realise and act upon the counsel which Mr. Smith embodies in one brief sentence: "The governmental duty to the mining industry first of all is to promote use without waste."

H. L.

THE SMOKE NUISANCE IN THE UNITED STATES.

LIKE ourselves, the industrial centres of the United States are beginning to realise the serious economic and hygienic effects caused by the unscientific combustion of coal. In the Journal of the Franklin Institute for March, Dr. W. F. M. Goss has contributed a paper on "Smoke as a Source of Atmospheric Pollution," in which he discusses the results of a very elaborate investigation, extending over six years, into the consumption of coal and loss in the form of smoke in the city of Chicago, an inquiry undertaken under the auspices of the Chicago Association of Commerce.

He begins by summarising the general results of previous observers in regard to the effect of smoke on health, on vegetation, and on the loss and damage to property, and then proceeds to discuss in detail the sources of industrial smoke in Chicago and the extent of wastage.

Smoke prevention

The amount of fuel (excluding liquid fuel) consumed annually in the industrial area of the city is estimated at about $17\frac{1}{2}$ million tons, and includes anthracite, coke, and bituminous coal, the last representing nearly one-half of the total. The following figures are given, though, as all experimental details are omitted, it is impossible to comment on the method by which they have been ascertained:—

Source	Coal consumed, tons	Average loss per cent.	Loss in tons	Percentage of total loss
Steam locomotives ...	2,099,044	1·084	22,750	7·47
Steam vessels	81,375	1·233	995	0·33
High-pressure boilers and public buildings.	7,316,257	0·805	58,867	19·34
Low-pressure boilers and private houses...	4,154,746	0·630	26,180	8·60
Gas and coke plant ...	234,551	—	—	—
Metallurgical and other furnaces	3,696,550	5·291	195,599	64·26
	17,582,523	1·808	304,391	100·00

The author discusses the causes of imperfect combustion and the best means of ameliorating the output of smoke; but as these are generally well known and recognised, at least in theory, they need not be reproduced. That smoke abatement is nearly always an indirect means of effecting economy is another well-established fact to which he refers. Dr. Goss points out the interesting observation, which may not be generally known, that the visibility or otherwise of smoke has no direct relation to its content of solid matter. The adoption of anthracite coal or coke as fuel will serve to render the discharge less visible, but will not eliminate the emission of dust or fine cinder. He appears to think that the replacement of coal by electrical energy will not reduce the amount of visible smoke to any serious extent, for steam raising will still be necessary. The more extensive use of gaseous fuel, smoke-washing, and electrical precipitation of smoke as a means of smoke abatement are passed over, for some unexplained reason, as not within the scope of the paper.

The author is not very optimistic in his outlook, for he considers that a revolution in practice which will result in the elimination of existing sources of atmospheric pollution is not to be expected "because present-day knowledge is insufficient to supply the necessary means, and, second, because the immediate application to all sources of pollution, even of such means as are now available, is mechanically and financially impracticable."

If by this statement Dr. Goss includes all forms of atmospheric pollution such as arise from gaseous impurities and dust particles blown into the air from the streets, etc., no doubt he is right; but he has himself shown that gaseous impurities are minimal in quantity, because they are rapidly dispersed, whilst dust particles, which exist everywhere, have never been regarded as causing injury either to animal or plant life.

But the really harmful constituents of a town atmosphere are unequivocally derived from one source—the incomplete combustion of coal, and there are few people who have studied the question in this country who are not thoroughly convinced that the pressure of properly instructed and firm control, supported by adequate legal penalties and the force of intelligent public opinion, would rapidly diminish and eventually eliminate an evil for which no economic or, indeed, any other excuse can exist. We are throwing away in a wanton and criminal fashion, without let or hindrance, a valuable inheritance which should belong to coming generations, and which they will never be able to recover.

J. B. C.

MAN AS A MACHINE.[1]

(1) A NUMBER of different experimental methods for determining the respiratory exchange of man have been employed in the past, some of which are designed for long experiments and some for short, and of late years it has become evident that a critical examination ought to be made with the view of determining how far the different methods give trustworthy and comparable results. A comparison of this kind involves very great labour, and Dr. Carpenter is to be congratulated on having undertaken the work. His investigation is throughout characterised by that careful attention to detail that we have learnt to associate with the Nutrition Laboratory at Boston of the Carnegie Institution.

The experimental methods examined in detail are the bed respiration calorimeter described by Benedict and Carpenter, two types of the Benedict universal respiration apparatus, and the apparatuses described by Zuntz and Geppert (the absence of the portable apparatus of Zuntz is perhaps a matter for regret), by Tissot and by Douglas. In addition, there is a description of accessory apparatus, including the Haldane gas analysis apparatus.

The experiments were made on resting subjects twelve hours or more after their last meal. In each experiment two of the different forms of apparatus were used either alternately or in series, the periods following each other as rapidly as possible. The three forms of Benedict apparatus were compared with one another, and the other methods were compared with the Benedict universal apparatus. Full tables of results are given, and these show that there is a wonderfully close agreement between the average figures obtained by the different methods.

In a critical discussion the author deals with the possible sources of error, as well as with the advantages and disadvantages of each of the methods.

In general comparable results can be obtained with all the methods investigated if care is taken, but preference is given to the Benedict apparatus, mainly on the ground that it is possible to obtain trustworthy results more quickly with it than with methods which involve volumetric gas analysis.

It would have lent additional interest to this discussion if a few comparative experiments could have been made during muscular work, as it is possible that some additional sources of error or inconvenience may become apparent when the different forms of apparatus are called upon to deal with a greatly increased respiratory exchange.

(2) The authors confine themselves in this publication to the calculation from the total respiratory exchange of the actual amount of energy liberated in the human body during walking exercise, but it is their intention to extend their observations in the future by means of direct calorimetry. An admirable introduction is afforded by an account of the previous history of the subject, amplified by an extensive table giving a complete summary of the results of previous observations.

The research has been conducted throughout in the laboratory on two athletic subjects. An ingenious form of horizontal treadmill is described, on which the subject walks at different paces, while the respiratory exchange is measured by means of the Benedict universal apparatus, various devices being employed for recording automatically the distance traversed, the number of steps taken, and the height through which the body is raised at each step.

[1] (1) "A Comparison of Methods for Determining the Respiratory Exchange of Man." By T. M. Carpenter. Pp. 265. (Publication No. 216 of the Carnegie Institution of Washington.) Price 2.50 dollars.
(2) "Energy Transformations during Horizontal Walking." By F. G. Benedict and H. Murschhauser. Pp. 100. (Publication No. 231 of the Carnegie Institution of Washington.) Price 1 dollar.

In attempting to estimate correctly the amount of energy used for the actual forward progression of the body it is essential to deduct from the total measured energy output a fraction which will represent what may be termed the basal maintenance metabolism, and it is somewhat difficult to decide what value to take for this purpose. The authors on the whole prefer to take as this basis the energy output found when the subject is standing still with the muscles relaxed, and this value certainly appears more reasonable than that found when the subject is lying at rest, though the latter has been used frequently by earlier workers on the subject. They have, however, considered other possible bases, especially with reference to walking at a very fast pace when pronounced movements of the arms occur.

With one of the subjects the pace was limited to slightly under three miles an hour, but with the other it was varied widely, ranging, roughly, from two and a half to five and a half miles an hour. As the pace increases the amount of energy output to move one kilo of the body weight one metre horizontally increases very greatly, as other observers have found. Some experiments performed with the subject running showed that it was more economical of energy to run than to walk at the rate of more than five miles an hour.

In examining the influence of food on the energy output during the exercise, the authors find that the increase in the metabolism due to the walking is at any given pace in the main constant and merely superimposed on the increased resting metabolism due to the food. With a large protein diet there is evidence that the heat output per unit of work is increased. Apart from the question of the absolute expenditure of energy, the figures in the various tables will be of extreme interest to any who wish to study the character of the metabolism during muscular exertion.

C. G. D.

THE GRAVELS OF EAST ANGLIA.

THE Cambridge University Press has published two interesting geological pamphlets by Prof. T. McKenny Hughes, the first on "The Gravels of East Anglia" (price 1*s*.), the second entitled "Notes on the Fenland," with a description of the Shippea man by Prof. A. Macalister (price 6*d*.). The gravels of East Anglia are especially useful in any inquiry as to the age and origin of the superficial deposits of our country, because of their wide distribution and the long continuous sections on the coast, in which many of them may be studied. They consist for the most part of subangular flints, which cannot have been derived directly from the chalk, and Prof. Hughes concludes that they are the débris of an old Miocene land-surface on which the chalk with flints was exposed. After a well-illustrated account of many sections, and a brief discussion of the mammalian remains found in the gravels and associated deposits, Prof. Hughes summarises the sequence of phases in the later geological history of East Anglia as he now understands them. All these gravels are of Pleistocene age, but the marsh-deposits of the fenland are distinctly later. They contain remains of the brown bear and the beaver, which survived in England until historic times, but none of the typical Pleistocene mammalia; while the most remarkable of the birds is the pelican. There is no definite chronological succession which will hold throughout the fens, and the relative dates of the various remains found in them cannot be well determined. The human skull and associated remains from Shippea Hill, described by Prof. Macalister, may be quite modern, though perhaps as old as the Bronze age.

THE ORGANISATION OF INDUSTRIAL SCIENTIFIC RESEARCH.[1]

II.

IT is the common opinion of those who have to deal with the organisation of research that only a small percentage of all the investigations started are likely to be successful, the great majority being either dropped before they come to an end, or, being carried through, are filed simply as records, without any results having been obtained which would justify the expense of the investigation; that is to say, industrial research is justified only by the great value of the successful attempts, and these must bear the burden of a great number of unsuccessful attempts, which may have been quite as costly as the successful ones themselves. Naturally, the object of organisation is to attempt to reduce the proportion of unsuccessful investigations which will be undertaken, as has already been shown. This can be done by increasing the size of the laboratory, by increasing the specialisation of the workers, and especially by increasing co-operation between workers in different fields.

Naturally, the most important step which could be taken to increase the efficiency of industrial research would be to increase the likelihood of correct choice of a promising investigation, but, unfortunately, very little can be done in this direction. Those with the most experience in research work are all agreed that it is almost impossible to say whether a given investigation will prove remunerative or not. The only general conclusion that can be drawn is that the deeper a given investigation goes towards the fundamentals of the problem the more likelihood there is that the results will be of value, and the more superficial an investigation is, even although it appears more promising at first sight, the less likelihood there is that it will finally prove of real worth, so that the choice of investigations must necessarily be made largely at random, and will be influenced to a great extent by the ideas of the scientific workers themselves; if any worker has a desire to take up any particular line of work, provided that it is associated with the general trend of work in the laboratory, it is usually wise to let him do so, but the expedition with which a decision can be reached as to the probable value of the investigation after it has been started is very greatly enhanced by the complete co-operation of workers in the different branches of science in consultation on the problem.

At this point it might be well to discuss the organisation of a large research laboratory. Such a laboratory should be established in charge of a director who has had some actual manufacturing experience in the works processes, but at the same time he must have a considerable sympathy with purely scientific work and an interest in the advancement of scientific theory. *Both* these qualifications are desirable, but if such a director combining the two cannot be found, then a man of full scientific training should be chosen and put into a position of responsibility in the manufacturing side of the industry until he has become fully acquainted with the technique of the industry. It is most inadvisable to take a man from the industry who has not had a full scientific training, including advanced research work in academic problems, since he will generally be lacking in sufficient knowledge of, and sympathy with, the more academic investigations of which he will be in charge, and if the two necessary qualifications cannot be found united in one man, it will be necessary to take a man with the scientific

[1] An address delivered at Columbia University by Dr. C. E. Kenneth Mees, director of the Research Laboratory, Eastman Kodak Co., Rochester, N.Y. Continued from p. 413.

qualifications and give him the practical training, which is just as essential for the director of a laboratory as scientific knowledge.

These necessary qualifications in the director are reflected in the division of the laboratory itself into manufacturing and scientific sections, since the manufacturing section should be able to carry out on a small scale all the chief manufacturing operations, so that any investigations made in the laboratory can be carried through to the practical works' scale without interfering with the production departments. In the research laboratory of the Eastman Kodak Company the manufacturing department includes emulsion-making and plate, film, and paper-coating departments, the capacity being very considerable, the plate department being able to make 300 dozen 8 in. by 10 in. plates a day. These departments are used not only for systematic experiments on emulsion suitable for various purposes, such as different kinds of plate emulsion, colour-sensitive emulsions, especially for colour photography, and experimental printing papers, but they are further used to make cn a small scale products which are required for special purposes in very small quantities, such as special plates required by astronomers or spectroscopists, or special films required for experimental purposes by those working on colour photography, or attempting to develop other photographic processes. Requests for such special materials are received by every large manufacturing company, and the execution of the orders in the production departments frequently involves much delay and loss, whereas the manufacturing section of the laboratory can carry out the work with a full understanding of the use to which the materials are to be put, and can often materially assist the purchaser in working out his idea. Co-operation of this kind between the general public and the laboratory cannot but be of advantage to both parties.

The manufacturing departments should be in charge of skilled foremen who have had previous experience in the works, and be run in exactly the same way as the production departments themselves, being under the general supervision of the director of the laboratory and of any assistants that it may be necessary for him to employ. The foremen of the departments should, however, co-operate very fully with the scientific departments.

There is always some difficulty in a laboratory in getting the scientific departments to make full use of the special knowledge of the manufacturing division and at the same time to realise the practical difficulties which occur in works processes, but this difficulty can be overcome much better in the case of the manufacturing division of the laboratory than it could if an outside production department were involved without the laboratory division acting as intermediary.

The scientific division of the laboratory should be divided into departments dealing with the special subjects, but every care should be taken that these departments do not become at all isolated from each other, and that they co-operate with each other in the most complete way on the solution of the problems on which the laboratory is engaged. In order to ensure this the main lines of work under investigation may be suitably discussed at a morning conference at the beginning of the day's work, one day of the week being assigned to each subject. The laboratory organisation will then resolve itself into a number of different departments engaged in dealing with a number of different lines of work, and the total work of the laboratory during the year may be suitably represented by a chart similar to that devised for the research laboratory of the Eastman Kodak Company.

The departments of the laboratory are represented as circles on the outside of the chart, the main divisions in which problems group themselves being represented by rectangles, subdivided in some instances, occupying the middle of the chart. Each of these rectangles will correspond to a morning conference; thus, a conference will be held on general photography, at which there will be present members of the photographic department, the physics department, the department of organic chemistry, and the emulsion and coating or manufacturing departments. There will be present at the conference, in fact, every scientific worker of the laboratory, whatever his rank, who is directly engaged on the subjects which are included under the head of general photography, and in some cases, or on special occasions, members of the staff of the company external to the laboratory may be invited to these conferences, although as a general rule in the case of a large company it will not be possible for them to be regularly present. All the main lines of investigation should be laid down at these conferences, and the progress from week to week carefully discussed. This procedure will enable a great saving in time to be made, since it will avoid the loss of time which continually occurs in laboratories from the wrong man doing a specific piece of work; and the economy can be much increased by a suitable arrangement of the building and equipment itself.

The building should be so arranged that all the laboratories are open to everybody in the scientific departments, but that in each laboratory involving special classes of apparatus there are specialists continually working who are available for consultation and assistance to all other workers in the laboratory. In this way single operations which become necessary in the course of an investigation may frequently be transferred from the man who has carried on the main line of work on the subject to some other specialist in the laboratory. In the Kodak laboratory, for instance, electrical measurements, photometric measurements, spectrophotography, lens optics, photographic sensitometry, work involving dyestuffs, and all strictly photographic operations, such as copying, lantern-slide making, printing and enlarging, making up developers, etc., are in the hands of specialists, and whenever any of these operations become necessary in the course of an investigation, the conference directs that they be carried out by the specialist on the subject. In this way an organic chemist, for instance, will have the absorption curve of his products measured, not by an instrument in the organic laboratory, but by the physics department, while the preparation of photographs, lantern-slides, and prints, which are often involved in publication, are carried on by the photographic department and not by the man who did the work, these arrangements relieving specialists in one subject from having to acquire technical skill in another. It is in such complete co-operation that the greatest economy in scientific investigation is to be found.

It must be remembered that such specialisation as this is not at all suitable for use in a university, where the object is the broadening and education of the students; it is one of the many differences between research work in a university and in a set research laboratory, whether it be industrial or not, that in a university the primary object is the training of the worker, while in the research laboratory the primary object is the carrying out of the investigation.

The best utilisation of the results obtained in an industrial research laboratory is only second in importance to the organisation required to obtain them. All results of general scientific interest and importance should undoubtedly be published, both in the public interest, and because only by such publication can the interest of the laboratory staff in pure science be maintained. It is doubtful if the importance of maintaining the full interest in theoretical science of a laboratory staff has been fully realised. When the men come to the laboratory they are usually interested chiefly in the progress of pure science, but they rapidly become absorbed in the special problems presented to them, and, without definite effort on the part of those responsible for the direction of the laboratory, there is great danger that they will not keep up to date in what is being done by other workers in their own and allied fields. Their interest can be stimulated by journal meetings and scientific conferences, but the greatest stimulation is afforded by the requirement that they themselves should publish in the usual scientific journals the scientific results which they may obtain. Another reason for publication is that when a piece of work is written up for publication the necessity for finishing loose ends becomes manifest, and that work which is published is therefore more likely to be properly completed.

With some laboratories publication is rendered difficult by the industrial organisation; while nominally manufacturing companies are usually willing that results of scientific interest should be published, the organisation of the company frequently requires that they should be passed on by the heads of several departments, such as the sales, patent, advertising, manufacturing, and so on, and the heads of these departments, possibly not understanding the subject, and being afraid of passing material which might prove detrimental, frequently err very much in the direction of withholding entirely harmless information from lack of sufficient knowledge. It is much more satisfactory, if possible, for one responsible executive to pass on all matter submitted for publication, and this will inevitably result in a much more liberal policy than where the responsibility is delegated to a number of representatives of different departments of the company.

In addition to these scientific papers special technical reports for the information of the staff of the company itself should be circulated by the laboratory, and in the case of the Kodak laboratory an abstract bulletin is published monthly giving information as to the more important papers appearing in the technical journals associated with the photographic industry and also of all photographic patents. It is often advisable, also, to prepare special bulletins dealing with the application of scientific investigations, which have already been published, to the special needs and interests of the company.

Since the evidence points, therefore, to the establishment of really large research laboratories as the most economical and efficient way of increasing the application of science in industrial work, the question arises as to how these large laboratories are to be supported. In the United States the great manufacturing corporations, who can afford the necessary capital and expenditure for maintenance, and are willing to wait for the results, have already undertaken the establishment of a number of large research laboratories. Such concerns as United States Steel, General Electric Company, United States Rubber, Du Pont de Nemours, and many others are supporting large and adequately equipped research laboratories, the staffs of which are engaged in work on the fundamental theory of the industries in which they are interested, and undoubtedly more and more such laboratories will be established in the course of the struggle for increased industry which the United States is preparing to wage. There are a large number, however, of smaller firms, who cannot afford the great expenditures involved, but who are anxious to benefit by the application of science to their work, and it seems that the only solution of the problem of providing for such firms is in the direction either of co-operative laboratories serving the whole industry, as has already been done in the case of the National Canners' Association and the National Paint Association, and no doubt in some others, or of national laboratories devoted to special subjects connected with industry and corresponding to such institutions dealing with special branches of pure science as the Geophysical Laboratory of the Carnegie Institution. Schemes for industrial scholarships tenable at universities do not meet the case at all, since work done under such arrangements must necessarily be directed towards a definite practical end rather than towards the general acquisition of knowledge connected with the underlying principles on which an industry rests. In the same way consulting laboratories, like industrial scholarships, are interested in the development of results for immediate practical application, and both these methods of work are substitutes for the practical industrial laboratories belonging to my second general division rather than for the large laboratories here discussed.

In England the co-ordination of industry has not proceeded as in the United States, and there are very few corporations who would be willing to maintain a large, fully equipped research laboratory of the type discussed, although a few such laboratories are well known to be in existence, but British industry has been brought very much together during the past eighteen months, and the organisation of industry is already a familiar phrase. Why, then, should England not establish a National Industrial Research Laboratory to assist all British manufacturers, and to develop the theory underlying the great fundamental industries on which British work depends? Such a laboratory could take the theory from the universities, or, where the theory was lacking, develop it and apply it to the separate industries, working out the results on a semi-manufacturing scale, and finally passing it on to the manufacturer. It may be of interest to glance at the possible size and scope of such an organisation, and I have attempted to formulate a scheme which will represent the minimum which would be required.

A laboratory on the smallest scale adequate to British industry would, at the beginning, require a staff of about two thousand men, one thousand of them scientifically trained and the other thousand assistants and workmen. It should have about three or four hundred men of the rank of professor or assistant professor in the universities, or of works manager or assistant manager or chief chemist in the factory. It would require land and buildings costing about 600,000*l.*, and its annual upkeep with allowance for expansion would be about 800,000*l.*

Vast as these figures are, they are infinitesimal compared with the value of the industries which they would serve. They represent a charge of less than 1 per cent., and probably not more than 1/5th per cent., of the net profits of British industry; moreover, after the initial period had been paid for, such a laboratory might be self-supporting, and might, indeed, finally make a very handsome profit on the original investment.

Suppose that such a laboratory patented all inventions and licensed manufacturers to use them, then, I think, it is not too much to expect that after the first five or six years it would be paying for itself, and that five years later it would be able to establish a great many subsidiary institutions from its profits; at any rate, such a vast laboratory would produce far more results at lower cost than would result from any other expenditure of a comparable sum of money on industrial research by the British industries.

I believe, however, that within the lifetime of most, if not all, of us we shall see such extensions of industrial research as will make all that we now have in mind seem insignificant, and it is because I believe so strongly in the importance of the subject that I have endeavoured to collect some impressions on the subject and to bring them before you this evening.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—At the assembly of faculties of University College on July 6, Dr. G. Carey Foster in the chair, the provost's report on the session 1915–16 was read. In addition to the services rendered in the Navy and Army by members of the college, laboratory and workshop accommodation has been utilised for various forms of war work. It is not permitted to give detailed particulars of the work done; but the departments that, from the nature of their work, have been particularly active are those of physics, chemistry, physiology, pharmacology, applied statistics and eugenics, and all the departments of the faculty of engineering. The effect of the war upon the college finances has been a cause of grave anxiety. This has been to some extent mitigated by a grant from the Treasury of 10,500*l.* and by the economies that it has been possible to introduce owing to the unsparing efforts of members of the academic staff in this direction, and owing also to the friendly co-operation of other London colleges, more especially King's and Bedford Colleges. The chief domestic event of the year is the occupation of the new chemistry laboratories. They are well on the road towards completion, but much equipment is still needed, and can only be provided as the means are forthcoming. Towards the sum of 20,000*l.* still required for this purpose, the benefactor, Sir Ralph Forster, to whom the college is largely indebted for the new chemistry buildings, has promised a sum of 5000*l.* provided the balance of 15,000*l.* is speedily subscribed.

The Executive Committee of the Household and Social Science Department of King's College for Women has appointed Miss Lane-Claypon to be the chief administrative officer of the department under the committee, with the title of dean. This office will be combined with that of lecturer on hygiene. The committee has decided upon this new appointment with the view of meeting the rapidly growing needs of the department. Dr. Lane-Claypon, who is at present an officer of the Local Government Board, will take up her duties next session.

MANCHESTER.—The total number of students in all faculties for the session just concluded was 1165. In the sessions 1913–14 and 1914–15 the numbers were 1654 and 1415 respectively. The list of past and present members of the university serving with H.M. Forces in the war, or engaged in approved war service, now numbers more than 1300. The number of past or present members of the university killed in action, died through the war, or reported missing has now reached 90.

Many of the departments of the university have been able to render special scientific service, both advisory and experimental, in connection with the war. Prof. Petavel is a member of the Government Advisory Committee on Aeronautics, and all the work now being done in the department of engineering under his direction has a bearing upon war problems, and is being placed at the service of the Government. Prof. Dixon has been appointed deputy-inspector of high explosives for the Manchester area, and all the high explosives manufactured in the district are tested in the university chemical laboratory. Prof. Lapworth has been authorised by the Ministry of Munitions to conduct a number of war researches, and a staff has been organised in his department for testing tars made in various gasworks in the country. Prof. Edwards and his assistants in the metallurgy department have been fully engaged in testing work for the Admiralty.

Sir E. Rutherford is a member of the Board of Investigation and Research of the Admiralty, and special investigations are in progress in the physics department dealing with the problems that engage the attention of that Board. The testing of optical instruments for the Ministry of Munitions is also carried on in that department.

In the school of technology a large staff of teachers and students is engaged in various kinds of work for the Ministry of Munitions and other departments of the Government.

Prof. Chapman has been appointed by the Board of Trade, and Profs. Calder and Dickie by the Admiralty, for special service in these Government departments. War work is also being conducted in the botany department for the Royal Aircraft Factory, and by Prof. Beattie in the department of electrotechnics.

The women teachers and students have organised two V.A. detachments of the Red Cross Society, and have been engaged in other forms of work for the relief of the sick and wounded soldiers in the Manchester hospitals.

Several of the elementary schools having been taken over for military hospitals, the museum committee, in consultation with the education authorities, has made arrangements for classes of students to be given in the natural history and Egyptology departments of the museum. By this arrangement effective instruction is provided for 900 to 1000 children per week in the museum.

THE next general meeting of the Association of Public School Science Masters will be held at Eton, under the presidency of Prof. H. H. Turner, on January 3 and 4, 1917.

THE trustees of the Beit Fellowships for Scientific Research, which were founded and endowed three years ago by Mr. Otto Beit, in order to promote the advancement of science by means of research, have elected to fellowships for 1916–17: Mr. H. N. Walsh, Cork (extension for a second year); Mr. W. A. Haward, Tufnell Park; and Mr. C. C. Smith, Bristol. The three Fellows will carry on their respective researches in the Imperial College of Science and Technology.

THE issue of the *Times* for July 15 gives some particulars of a meeting on July 6 between the parents of boys at twenty-six of the principal public schools and a committee of public school headmasters. The attitude taken up by some of the headmasters showed a misapprehension of the claims made by the champions of the value of a training in science in the education of all. To study science is not of necessity to become materialistic, and science and materialism are not by any means synonymous terms, though one headmaster argued as if they were. The man of science values as much as others high-mindedness and real character, but he urges that these may be secured side by side with an acquaintance with modern science and general efficiency. The headmaster of Harrow explained that in his school all boys are compelled as part of their school career to learn science, and any boy with special scientific ability was encouraged to develop it. A wrong use may be made of many good gifts, and because modern research may be directed to destructive ends is no reason why our boys should leave school ignorant of subjects which will be essential in the coming economic struggle, and without a knowledge of which efficiency in the various departments of a modern State is impossible.

THE terrible conflict in which we, together with the chief civilised nations of Europe, are now engaged has served to awaken in this country a deep unrest as to educational results and methods, especially in respect of the place of science in education. This question formed the subject of a significant article by Prof. J. A. Fleming, F.R.S., in the Journal of the Royal Society of Arts for June 23. In this article Prof. Fleming seeks to lay the true foundations of national education for all classes of the people, and he demands that a careful and searching analysis shall be instituted into the causes which have led to our failure to cultivate sufficiently scientific knowledge and to estimate its proper place and function in general education. The true philosophy of education is to enable the child to educate himself, for he is naturally a philosopher, an experimentalist, and an artist, and the best we can do is to direct his activities into right channels, to teach him how to *do* things, and especially to bring the town-born child into closer touch with Nature. As to the secondary and public schools a complete change is demanded in the curriculum, even to the extent of the abolition in the latter of the present division into classical and modern sides, so that the various great groups of educational subjects—languages and literature; science, or a knowledge of the facts and laws of the universe; mathematics and graphics; religious and ethical instruction; history; economics; the duties of citizenship; and physical care—may be put upon a footing of strict equality in the school course. The right methods of scientific teaching applied to all branches of study, the importance of experimentation on the part of the pupil rather than that of much lecturing, the value of re-discovery, under due guidance, of the elementary laws and facts of science, are strongly insisted upon. So in the universities their function should be not so much the dissemination of scientific knowledge as the due training and instruction of men who can create new knowledge, it being the main duty of the university to increase by means of research the sum of knowledge based upon that already gained, opening up for the first time some novel and rich mine of scientific truth. Every encouragement should be given to men of original powers of mind, and we need to search diligently for such men in the firm belief that "there are revolutionising discoveries and inventions yet to be made which will affect human life in every way."

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, July 3.—Dr. Horne, president, in the chair.—Dr. R. **Kidston** and Prof. W. H. **Lang**: On Old Red Sandstone fossil plants showing structure, from Rhynie Chert Bed, Aberdeenshire. Well-preserved silicified plant remains have been found in a chert band not younger than the Middle Old Red Sandstone. There are two vascular plants, *Rhynia gwynne-vaughani*, n.sp. and n.g., and *Asteroxylon mackiei*, n.sp. and n.g. The plants of Rhynia grew closely crowded together, and their remains formed a peat. The plant was rootless and leafless, consisting entirely of a system of cylindrical stems. Rhizomes were fixed in the peat by rhizoids, and tapering aerial stems grew up from them. These stems bore small hemispherical projections, and branched dichotomously and laterally. They had a thick-walled epidermis with stomata, and a simple central cylinder consisting of a strand of tracheides surrounded by phloëm. Large cylindrical sporangia, containing numerous spores, were borne terminally on some of the leafless aerial stems. The plant is compared with some of the specimens of *Psilophyton princeps*, figured by Dawson; and a new class of vascular cryptogams, the Psilophytales, is founded for their reception. This is characterised by the sporangia being borne at the ends of branches of the stem without any relation to leaves or leaf-like organs. A comparison is made between Psilophytales and the existing class of Psilotales.—Dr. R. **Kidston**: Contributions to our knowledge of British Palæozoic plants. Part I.: Fossil plants from the Scottish coal measures. The paper contains descriptions of new or little-known species.—Dr. W. B. **Blaikie**: Exhibition of a universal sun-dial giving any standard mean time and of a diagram giving sunrise and sunset in mean time for all longitudes and latitudes. The dial was mounted equatorially, and was translucent, so that a shadow could be cast whether the sun shone from above or from below. A simple rotation set the instrument to the mean time for any longitude, and a tangent screw adjustment applied the equation of time with great simplicity. The diagram consisted of two ruled surfaces, of which the upper was transparent. When the graduation representing latitude on the one was made to coincide with the graduation representing declination on the other, certain radial lines gave the times of sunrise and sunset.—Prof. M. **Maclean** and D. J. **Mackellar**: On the heating of field coils of dynamo-electric machinery. Temperatures were measured by thermometers, by resistance measurement, and by thermo-couples placed at different points in the coil. Results were obtained for various conditions of load and for various speeds, and were discussed under the two heads: (1) the effect of the armature current, (2) the effect of armature peripheral speed.—Dr. M. **Kojima**: Preliminary communication on the effects of thyroid feeding upon the pancreas. The work had been carried out in the physiological laboratory of the University of Edinburgh. It was found that the addition of a certain amount of thyroid to the food of animals (rats) produced pronounced morphogenetic changes in the pancreas. After a few days' feeding, the gland cells multiply, their nuclei exhibiting marked evidence of karyokinesis. Accompanying this change there is a decided diminution in the amount of zymogen contained in the cells, which are now much smaller than normal. After two or three weeks the cell-multiplication ceases and zymogen again accumulates, so that the cells increase in size, a general enlargement of the gland being ultimately effected.—J. **Littlejohn**: The application of operators to the solution of the algebraic equation. The operators were differentiations and integrations with respect to the coefficients, and it was shown how the roots could be evaluated in the case of numerical equations.—Dr. H. **Bateman**: On systems of partial differential equations and the transformation of spherical harmonics. The paper showed how the general equation of wave-motion associated with Maxwell's electromagnetic theory could be transformed into the Laplacian form of equation in three variables. Thus the electrostatic vector **E** can be expressed in the form Grad V, where V is a solution of the Laplacian equation in terms of the variables X, Y, Z, which are functions of the original variables x, y, z, t. The result is that a solution of Laplace's equation in X, Y, Z is a solution of the wave equation in x, y, z, t.

PARIS.

Academy of Sciences, June 26.—M. Camille Jordan in the chair.—G. **Bigourdan**: The propagation of sound to a great distance. It is established that the cannonade at the front has been heard at a distance of 250 kilometres.—A. **Gautier**: The historical origin of the sugar-cane and cane-sugar. Cane-sugar was used in China in A.D. 749, and introduced into Japan a century later. It did not reach Europe until after the Crusades, and was grown in Spanish America in 1566. —L. **Landouzy**: Predispositions, innate or acquired, to tubercular infection.—Dr. Ramon y Cajal was elected a correspondant for the section of anatomy and zoology in the place of the late Jean Perez, and Prof. Morat a correspondant for the section of medicine and surgery in the place of the late M. Zambaco.—R. **Birkeland**: Some important formulæ and their applications.—N. **Lusin**: Research in primitive functions.—C. **Benedicks**: The determination of thermoelectric power by means of the differential galvanometer. The exact determination of the difference of temperature between two given points of a good conductor requires the use of two thermo-couples. If these are joined separately to the two circuits of a differential galvanometer, the difference of temperature can be obtained with greater precision than by following the usual method.—P. **Choffat**: Volcanic phenomena on the Portuguese coast north of the Tagus.—S. **Stéfanescu**: The origin of the lozenge-shaped figures of the dental plates of elephants (Loxodon).—Ch. J. **Gravier**: Incubation in *Actinia equina* at the island of San Thomé (Gulf of Guinea).

July 3.—M. Camille Jordan in the chair.—J. **Bergonié**: Powerful electro-vibrators working with small current, continuous or alternating. A resonance electro-vibrator. In a previous paper the author described an electro-vibrator for detecting and extracting fragments of projectiles, using from 550 to 950 watts, but, on account of the high self-induction, requiring 60 amperes at 200 to 220 volts. By compensating the self-induction with a capacity the power required can be much reduced. Thus in such a resonance electro-vibrator recently constructed, working on an alternating current of 110 volts, 42 periods, 7·5 amperes were taken, and its electromagnetic action is the same as that of an apparatus without a capacity, with a current of more than 100 amperes.—Dr. Boulenger was elected a correspondant for the section of anatomy and zoology, in the place of Prof. Waldeyer. —R. **Garnier**: Study of the general integral of equation (VI.) of Painlevé in the neighbourhood of its transcendental singularities.—E. **Gadeceau**: The submerged forests of Belle-Ile-en-Mer.—A. **Nodon**: Observations on the terrestrial electromagnetic disturbances.—A. **Lameere**: A new phase of Dicyema.—Ch. **Dhéré** and G. **Vegezzi**: Acid hæmochromogen.

BOOKS RECEIVED.

Laboratory Manual in General Microbiology. Pp. xvi+418. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 10s. 6d. net.

Arithmetic for Engineers, including Simple Algebra, Mensuration, Logarithms, Graphs, and the Slide Rule. By C. B. Clapham. Pp. xi+436. (London: Chapman and Hall, Ltd.) 5s. 6d. net.

The World and its Discovery. By H. B. Wetherill. Four parts. (London: At the Clarendon Press.) 1s. each.

Contents and Index of the Memoirs of the Geological Survey of India. Vols. xxi.-xxxv., 1884–1911. By G. de P. Cotter. Pp. iv+119. (Calcutta: Superintendent Government Printing.)

The Statesman's Year Book. Fifty-third Annual Publication. Edited by Dr. J. Scott Keltie, assisted by Dr. M. Epstein. Pp. xliv+1560+plates iv. (London: Macmillan and Co., Ltd.) 10s. 6d. net.

Shakespeare's England: An Account of the Life and Manners of his Age. Vol. i., pp. xxiv+546. Vol. ii., pp. x+610. (London: At the Clarendon Press.) Two vols., 25s. net.

Tales from a Boy's Fancy. By A. Shawmeker. Pp. 320. (Kansas City: Burton Publishing Company.) 1 dollar 50 cents.

A Manual of Mendelism. By Prof. J. Wilson. Pp. 152. (London: A. and C. Black, Ltd.) 2s. 6d. net.

The Dreams of Orlow. By A. M. Irvine, with an introduction by J. A. Hill. Pp. 256. (London: G. Allen and Unwin, Ltd.) 5s. net.

A Course in Mathematical Analysis. Functions of a Complex Variable, being part i. of vol. ii. By Prof. E. Goursat. Translated by Prof. E. R. Hedrick and O. Dunkel. Pp. x+259. (Boston and London: Ginn and Co.) 11s. 6d.

A Text-book of Physics and Chemistry for Nurses. By Profs. A. R. Bliss and A. H. Olive. Pp. xiv+239. (Philadelphia and London: J. B. Lippincott Company.) 6s. net.

A Modern Job: an Essay on the Problem of Evil. By E. Giran. Translated by F. Rothwell. Pp. 92. (London: Open Court Publishing Company.) 2s. 6d. net.

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Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.

Telephone Number: GERRARD 8830.